Middle Palaeolithic technological adaptation in Montane Southwest Asia: a test of the Zagros Mousterian "Summer adaptation hypothesis"

Middle Palaeolithic Technological Adaptation in Montane Southwest Asia: A test of the Zagros Mousterian "Summer Adaptation Hypothesis"

Andreas Nymark

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Declaration

This dissertation is the result of my own work and includes nothing which is the outcome of work done in collaboration.

Andreas Nymark

Abstract

The Zagros Mousterian techno-complex, known from Middle Palaeolithic high-altitude contexts of the Zagros Mountains of Iraq and Iran, has been argued to be the techno-behavioural expression of exclusively summer-seasonal exploitation by hominins. The "Summer Adaptation Hypothesis" aims to investigate this contention through lithic attribute analysis of Middle Palaeolithic material, and through discussion of relevant environmental data. This thesis analyses and discusses three Zagros Mousterian lithic assemblages, Shanidar Cave Layer D4, Warwasi layers WW and XX, and Houmian Layer 2a, and one Levantine Mousterian assemblage, Ksar Akil layers XXVIIIA, XXVIIA, and XXVIA. This thesis aims to demonstrate that the contention that only summer exploitation was feasible throughout the Pleistocene is not in line with either the lithic or the environmental evidence. The results of the lithic analyses are argued to support the viewpoint that the Zagros Mousterian is not a techno-behavioural expression of exclusively summer-seasonal exploitation of high-altitude environments, and that the Zagros Mousterian is not, in itself, a coherent techno-complex in the first place.

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This has been a long journey. From finding a flake of a polished Neolithic axe on my first survey, aged four, on a field in Samsø, this has been a lengthy steadfast grind towards coveted completion. While this creation will not be placed in a bog for the gods, I wonder if people down the generations will look at it with amazement contemplating whether it was indeed functional in its time or for purely ornamental purpose.

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Table of Contents

List of Figures

List of tables

Chapter 1 - Introduction

1.1 Background and rationale

Much is already known about hominin adaptational strategies in the southwest Asian Middle Palaeolithic. Historically, the coastal Levantine region has received most attention (e.g. Akazawa et al. 1998; Hovers 2009; Shea 2013; Enzel and Bar-Yosef 2017), but within the last four-five decades also the arid interior of Syria has seen a well of information brought forth (Akazawa et al. 1973; Boëda and Muhesen 1993; papers in Aurenche et al. 2004; Conard et al. 2004; Dodonov et al. 2007; Conard et al. 2010; papers in Le Tensorer et al. 2011; Shaw 2012; Boëda et al. 2015; Pagli 2015;). In contrast, the Middle Palaeolithic of the montane regions of the Zagros to the east are still poorly understood due to more sporadic exploration and lack of definitive publications of old excavations (Garrod 1930; Field 1951; Solecki 1955; Solecki 1963; Skinner 1965; McBurney 1970; Bewley 1984; papers in Olszewski & Dibble 1993; Lindly 1997; Heydari-Guran 2014).

As renewed investigations at the key Middle-Upper Palaeolithic site of Shanidar Cave were initiated in 2014 (e.g. Reynolds et al. 2015; Pomeroy et al. 2017, 2020), this study finds it timely to provide a backdrop by re-appreciating the under-researched Middle Palaeolithic of the Zagros Mountains by exploring the main concept for its understanding: The Zagros Mousterian.

1.2 Hypothesis of the thesis

1.2.1 The Zagros Mousterian and the "Summer Adaptation Hypothesis"

In the mid-20th Century Skinner (1965) first introduced the concept of the Zagros Mousterian as a distinct Middle Palaeolithic techno-complex found in the montane regions of Iraq and Iran within southwest Asia. In the late 20th Century Lindly (1997) defined the Zagros Mousterian further as being the techno-behavioural expression of ephemeral summer-seasonal adaptation by hominins to high-montane environments. This thesis will endeavour to test this "Summer Adaptation Hypothesis", adopting the assumption that a rejection of it would mean that hominins were capable of more complex behaviour (i.e. multi-seasonal exploitation of high-altitude environments) than thus far appreciated. Of more wide-reaching consequences would be the refutation of the underlying typological system, the Zagros Mousterian techno-complex, as a rejection of the former would, by definition, be a rejection of the latter. In other words, if the Zagros Mousterian is *not* a distinct techno-complex, it cannot be considered a *single* (summer) adaptation. Consequently, the validity of the "Summer Adaptation Hypothesis", and by extension the Zagros Mousterian techno-complex as a whole, is the main fulcrum of this thesis.

1.3 Framework for research - Two stages of enquiry

1.3.1 Stage one

This thesis will engage with the main hypothesis in two stages. First through a history of research of the Levantine Mousterian of southwest Asia, from where the Zagros Mousterian is commonly understood to relate. This will be done to review the progression of concepts of Middle Palaeolithic hominin behavioural evolution in general, and lithic typological organisation in particular, leading up to the formulation of the Zagros Mousterian as an independent techno-complex. Through this its foundations will be illuminated permitting a contextual grounding from where to review its own foundation for, and articulation with, the "Summer Adaptation Hypothesis".

1.3.2 Stage two

The second and main stage of testing the hypothesis will be the case study of the utilisation of the Zagros Mousterian as an interpretive framework to explain hominin behaviour through lithic variability within a selection of Zagros Mousterian site assemblages. This thesis analyses three "Mousterian" Middle Palaeolithic lithic assemblages commonly argued to be Zagros Mousterian from three Zagros Mountain sites: Shanidar Cave, Warwasi, and Houmian. The findings are discussed and compared to a Levantine Mousterian assemblage from the Levant: Ksar Akil (Figure 1).

The reasoning for the comparison of the three Zagros assemblages to a Levantine one is to test the claims of the usefulness – and thereby the validity – of the Zagros Mousterian techno-complex, as defined by Skinner (1965), to account not only for techno-typological idiosyncrasies found in Middle Palaeolithic lithic assemblages in montane southwest Asia, but also to explain those techno-typological idiosyncrasies through a specific techno-behavioural framework, as proposed by Lindly (1997).

It is well known that older collections of lithic assemblages from the Zagros Mountains usually have significant interpretative constraints, pertaining to their excavational history, leaving many with only very limited environmental and chronometric proxy data, with which to engage in intra- and inter-site comparisons. This is true at different levels for the three Zagros assemblages presented in this thesis, as will be discussed in later chapters. This is not, however, considered to be either a conceptual or practical issue for the study in this thesis, as the validity of the "Summer Adaptation Hypothesis", as it has been formulated based on the assumption of homogeneity of the Zagros Mousterian techno-complex as proposed and presented by Lindly (1997, 2005), will use similar lines of analyses in the attempt of its disarticulation as were used in its original composition. As such, the techno-typological method of attribute analysis will function as the main device of examination. The lithic attribute analysis will be augmented, to the extent this is possible, with direct and indirect climatic, environmental, and physiographic data. This is also in line with the methods used to originally argue for the validity of the Zagros Mousterian techno-complex.

1.4 Structure of the thesis

In the following Chapter 2, a history of research will be presented, in order to situate the Zagros Mousterian within the Middle Palaeolithic of southwest Asia. This background will highlight the reason for the conception of the Zagros Mousterian as a techno-complex and provide an understanding of differences and similarities between the Levantine and Zagros Mousterian.

Chapter 3 will present an overview of climatic, environmental, and physiographic issues pertinent to the understanding of the possible Pleistocene landscapes of the Zagros Mountains. This background will help with appreciation of the multiple possible factors which could have played a part in changes and stability to weather and environment at various times in the Pleistocene, and should be taken into account in any prediction of long-term estimate of climate within a given region. This chapter will also present the physical setting of the selected sites, within a model of Palaeolithic landscapes.

Chapter 4 presents the methodology for the lithic attribute analysis used to analysis the four assemblages.

Chapters 5-8 presents the four lithic assemblages of Houmian, Shanidar, Warwasi, and Ksar Akil.

Chapter 9 presents a comparative analysis of the four sites and discusses its implications. The results will be discussed in relation to the "Summer Adaptation Hypothesis", and whether the validity of this hypothesis can be said to be upheld base on a contextualisation between the lithic and environmental data presented.

Chapter 10 offers a conclusion on the findings of the thesis, and presents various avenues for future research into the archaeology of the Middle Palaeolithic of the Zagros.

1.5 Aims of the thesis

The aim of this thesis is to use the results of the testing of the Summer Adaptation Hypothesis to advance our understanding of Middle Palaeolithic hominin behaviour in the Zagros Mountains.

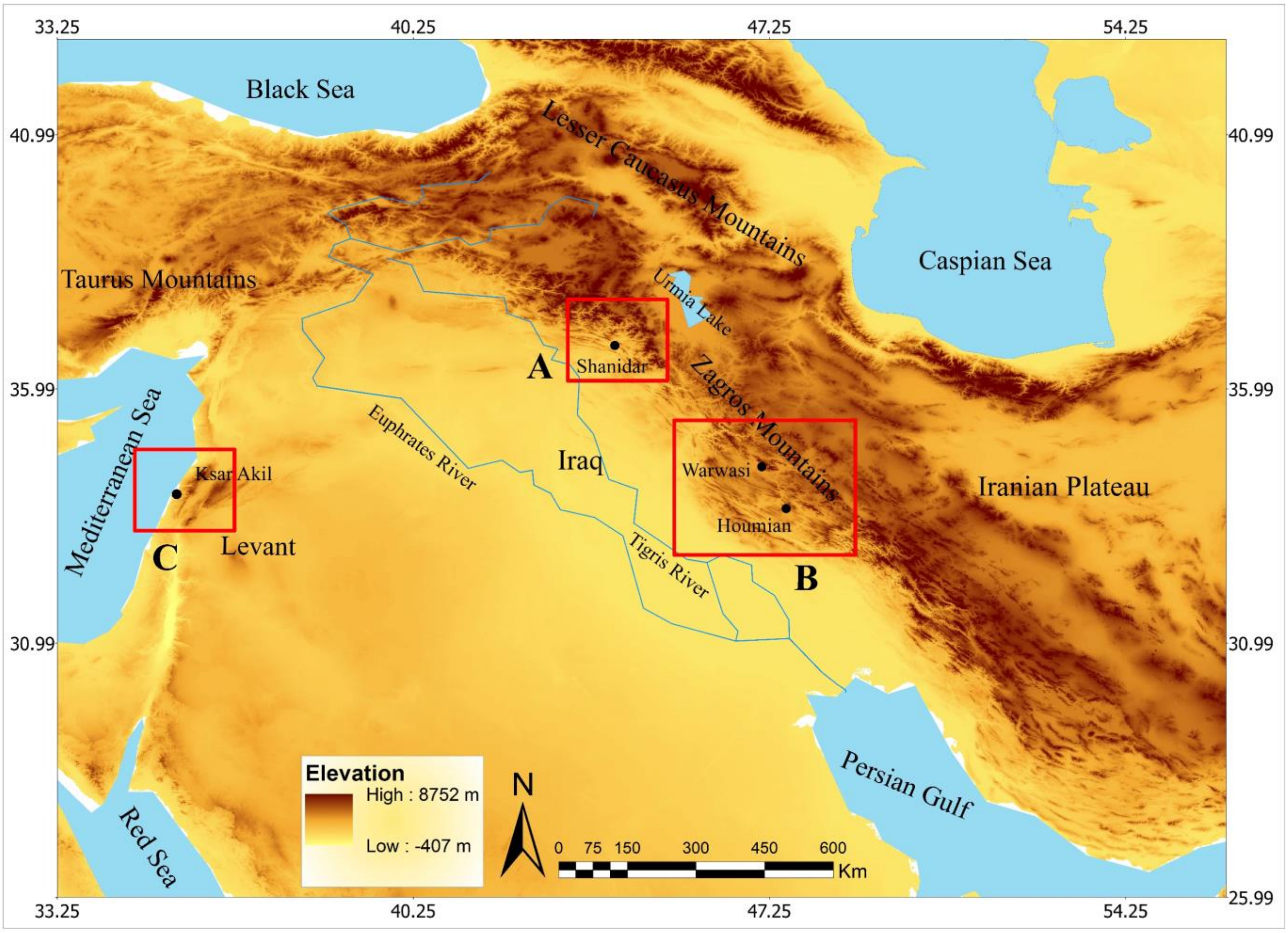

Figure 1 - Regional map of southwest Asia, including the Zagros and the Levant, with locations of Houmian, Warwasi, Shanidar, and Ksar Akil.

Chapter 2 - The Middle Palaeolithic of southwest Asia in context

2.1 Neanderthals and modern humans in southwest Asia

While not as historically celebrated as the Upper Palaeolithic (e.g. Mellars 1989; Bar-Yosef 2002), where modern humans outlived the eventual extinction of the Neanderthals and prevailed as the most successful hominin species, the Middle Palaeolithic for many decades has been an important focal point in the pursuit of knowledge about our species, those that came before, and how those events effected what came after.

The Middle Palaeolithic is argued as resulting from a suite of changes to hominin lifeways brought about through, possibly interrelated, physical and behavioural evolution in conjunction with severe changes to climate and environment at the transition between the Middle to Upper Pleistocene, more specifically around MIS 8 and MIS 7, between 300-250 ka (e.g. Foley and Larr 1997; Bar-Matthews and Ayalon 2004; Finlayson 2004; McGarry et al. 2004; Hovers 2009; Shea 2013). The interpretations based on the available data suggest that this significantly differs from the preceding Acheulean (e.g. Henry 2003; Shaw 2012; Shea 2013; Churchill 2014; Rosell and Blasco 2019).

In a southwest Asian context, evidence indicates that two types of hominins were responsible for generating the material culture record, the principal form of data through which archaeologists seek to acquire knowledge about the Palaeolithic, today associated with this particular period: these are *Homo neanderthalensis* (Neanderthals) and *Homo sapiens* (both archaic *Homo sapiens* and anatomically modern humans). Closely related in the genus *Homo* through the assumed common ancestor, *Homo heidelbergensis* (Stringer 1983; Stringer 2012; Rogers, Bohlender, and Huff 2017; Godinho et al. 2018), Neanderthals evolved in western Eurasia whereas modern humans originated in Africa (Rightmire 1998; Mounier et al. 2009).

Neanderthals and modern humans almost certainly co-existed within southwest Asia (Mercier & Valladas 1994; Grün et al. 2005), as claims have been made for evidence there of interbreeding (Sankararaman et al. 2012). If this can be substantiated, it is likely these two apex predators occupied or exploited similar habitats (Shea 2003).

Relating to this issue, two opposing views are debated in the literature with regards to Neanderthal and modern human occupation of southwest Asia. One view sees the hominin fossil and material culture record in the Levant, *sensu lato*, as indicating evolutionary continuity (Howell 1959; Garrod 1962; Binford 1968; Jelinek 1982b; Kaufman 1999; Hovers 2006), while the other interprets the same material to indicate extinction events (Shea 2008, 2011), leading Shea (2007:229) to label the Levant a 'boulevard of broken dreams'.

An issue specific to southwest Asia is the fact that both species have been associated with the same kind of "Mousterian" toolkit (McCown and Keith 1939; Bar-Yosef 1998), and that the attribution to either hominin species sometimes can prove problematic. Mousterian lithic assemblages in and of themselves therefore are notoriously difficult to use to assert either Neanderthal or modern human presence.

As the issue of distinguishing between assemblages produced by Neanderthals and modern humans are not the scope of this thesis, but rather if the assertions about exclusivity of summer-seasonal exploitation of the Zagros Mountains (Lindly 1997) can be validated through the lithic and climatic evidence, specific assumptions about the species responsible for the assemblages will not be pursued.

2.2 Behavioural complexity and regional variability: the three spheres

As Shea (2013) in his authoritative synthesis points out, not only do we see a surge in behavioural complexity observable in the archaeological record during this period, we also witness the first evidence for large scale *regional variability* within this behavioural complexity (Shea 2013: 81-82).

For southwest Asia three spheres of such behavioural complexity is attestable: These are related to symbolism, fauna, and technology (Shea 2013: 81-82; Boëda et al. 2008; Goren-Inbar 2011; Hauck 2011). While some traits within these spheres display local (e.g. Wojtczak 2011) or sub-regional (e.g. Jagher and Le Tensorer 2011) distributions, others seem to be present more widely at various sites throughout southwest Asia (e.g. Lindly 1997). The occurrence of, and wealth within, each of these three spheres of behavioural complexity individually merits investigation. It is, however, the cumulative effect of the three spheres together which make southwest Asia interesting as a study area. While the present study will not incorporate the spheres of symbolism or fauna directly, as the implications of complexity in hunting methods (Boëda et al. 1996; Shea and Sisk 2010) and capability for complex use of symbols by hominins (Chase and Dibble 1987; Hovers, Vandermeersch and Bar-Yosef 1997) are qualities particularly associated with Middle Palaeolithic behaviour, a brief review is warranted, as it helps provide a cognitive behavioural context to the socio-economic dimensions of the material culture record of lithics which will be the foundations of this study.

2.2.1 Symbolism

Up until the last decades of the 20th century, formalised use of symbolism through material culture was considered to be an intrinsically modern human enterprise (Mellars and Stringer 1989; Klein 1995), a corporal mark of the notorious concept of *behavioural modernity* (Davies 2009; Nowell 2010), associated with the Upper Palaeolithic (Bar-Yosef 2002; Mellars 2005). While there have been sporadic claims for the capacity for expression of symbolic behaviour among *Homo erectus* (Goren-Inbar 1986; d'Errico & Nowell 2000; Joordens et al. 2015), few researchers would argue this constitutes confirmation of fully fledged "*modern*" behaviour, let alone evidence of a complex society. Although preservational issues could be invoked together with the truism that absence of evidence does not necessarily reflect evidence of absence, surely a distinction of the nature, context, and pervasiveness of the symbolic manifestations of a species must be made between being able to produce it and being able to use it (Nowell 2010: 442).

The seminal paper by McBrearty and Brooks (2000) on the evidence for widespread antecedents in Africa of "*modern behaviour*" predating that of the European Upper Palaeolithic, has served as a catalyst resulting in a current consensus which has well established the capacity for, and use of, symbolic behaviour such as production and use of mineral pigments and personal adornments among both Neanderthals and modern humans during the Middle Palaeolithic and Middle Stone Age (d'Errico & Henshilwood 2005; Bouzouggar et al. 2007; Bar-Yosef Mayer et al. 2009; d'Errico et al. 2009; Henshilwood et al. 2009; Peresani et al. 2011, 2013; Radovčić et al. 2015, 2020).

For southwest Asia, particularly, the argued evidence for human burials has received much attention, from the so-called Neandertal 'Flower Burial' at Shanidar Cave in the northern Zagros mountains (Solecki 1975; Trinkaus 1983; Sommer 1999; Pomeroy et al. 2020a, b), over the Neanderthal child burials at Dederiyeh Cave, northwest Syria (Akazawa et al. 1993; Akazawa et al. 1995; Akazawa et al. 1999), to the alleged occupational overlapping of Neanderthals and modern humans in the costal Levant suggested by the dating of remains of both species retrieved from claimed burial contexts: the former within the cave of Tabun (Garrod & Bate 1937; Defleur 1993), and the latter from Skhul Cave (McCown 1937; Mercier et al. 1993; Grün et al. 2005) and Qafzeh Cave (Neuville 1951; Vandermeersch 1981; Schwarcz & Grün 1988; Vandermeersch 2002) in Israel.

To underscore the intentionality of inhumations and stress the cultural aspect in such behaviour, associated mortuary furniture reported by excavators from various Middle Palaeolithic burials throughout southwest Asia testifies to the social use of material culture in a symbolic context (Bar-Yosef et al. 1991; Akazawa et al. 1995; Hovers et al. 1995).

It is thus within the variability of a behaviourally advanced material culture – be it *H. sapien* or Neanderthal – that we are offered sufficient insight into the complex lifeways of Middle Palaeolithic hominin society with which to offer coherent descriptions, confident analyses, and tangible explanations of the deposition of that material culture in the context of negotiating survival. For this reason, the widespread evidence for a symbolic behavioural sphere augments the faunal and technological spheres, making the Middle Palaeolithic of southwest Asia a rigorous body of data within which to ground research questions of hominin behavioural evolution.

2.2.2 Fauna

While hominins are omnivorous, studies in paleobiology and evidence from faunal remains associated with their occupations suggests a clear focus on meat procurement in the Middle Palaeolithic (e.g. Stanford & Bunn 2001; Adler and Bar-Oz 2009; Stiner and Kuhn 2009; Sørensen 2009). During the Middle Palaeolithic of southwest Asia intensified hunting and exploitation of specific types, and sizes, of animals become more evident, as seen in the faunal assemblages published in the literature (Vita-Finzi & Higgs 1970; Evins 1982; Garrard 1983; Marean & Kim 1998; Speth & Tchernov 1998; Stiner & Tchernov 1998; Speth 2002; Speth & Tchernov 2002; Speth & Tchernov 2003; Speth 2004; Griggo 2004; Stiner 2006; Speth & Clark 2006; Speth 2013).

The proportional frequencies of faunal remains, compared to human remains, in the Middle Palaeolithic archaeological record, make them more generally available for study, and thereby have the potential to indirectly complement the information accessible through lithic assemblages towards the reconstruction of hominin behaviour.

Besides affording a general idea of hominin prey preference and subsistence strategies in a particular area, interdisciplinary studies of faunal assemblages can provide a wealth of knowledge about game seasonal movement and mortality rates, which can be used as proxy data for the reconstruction of both more fine-grained hominin behaviour like settlement dynamics, mobility, and seasonality, and wider paleolandscape reconstruction (Haverkort et al. 2008; Richards et al. 2008; Mainland 2010; Britton et al. 2011; Slovak & Paytan 2011).

With regards to the published faunal assemblages excavated from the Mousterian Zagros sites under study in this thesis, issues constraining interpretive regimes are more pervasive than they are with the lithic assemblages. While suffering, like the lithics, from various degrees of lacking sufficient chrono-stratigraphic context, the preservational issues are exacerbated by their vulnerability to decay. Further, while lithic assemblages are intrinsically associated with one predator, hominins, deposited faunal material extracted during excavation sometimes can be attributed to other predators, such as lion, leopard, or wolf (see below), in which case it cannot be used to contextualise the lithic assemblages in pursuit of behavioural regarding hominin site-use.

A brief description of these three faunal assemblages is warranted, however, as they do contain some valuable insight into hominin site-use, but also serve to demonstrate their interpretative limitations.

As a backdrop for the presentation of the results from the faunal studies, a brief outline of the modern faunal community composition of the Zagros Mountains will be offered.

2.2.2.1 Modern faunal community composition of the Zagros Mountains

An ecosystem, or in the case of the Zagros Mountains, multiple ecosystems (see Chapter 3), are environments where animals and humans are likely to interact with each other in their pursuit of negotiating survival. The Zagros Mountains today have a very varied faunal community (Firouz 2005).

Herbivores

The undomesticated wild goat (*Capra aegagrus aegagrus*), bezoar ibex, a subspecies of the *Capra aegagrus*, inhabits the mountainous and mountain forest areas. While preferring rocky environments, modern threats include loss of habitat due to logging and grazing of domesticated goat (*Capra hircus*) as well as hunting. The mouflon (*Ovis gmelini*), while adapted to more varied environment, also prefers mountain habitats, as well as temperate forest. Historically common, many species of deer have either become extinct or endangered over the past 50-70 years (Laylin 2018). Among those are red deer (*Cervus elaphus*) and roe deer (*Capreolus capreolus*), and the Persian fallow deer (*Dama dama mesopotamica*, e.g. Grubb (2005: 665) or *Dama mesopotamica*, e.g. Pitra et al. (2004)), once thought extinct, today is on the national endangered-species list in Iran, and found only in the western Zagros foothills (Firouz 2005). Three separate clades of goitered gazelle (*Gazella subgutturosa*) have recently been identified in Iran, with one pertaining to the western side of the Zagros, one to the north-central regions on the eastern side of the Zagros, and one to the northeast of Iran (Fadakar et al. 2020). The onager, or Asiatic wild ass (*Equus hemionus*), of which the subspecies Persian wild ass (*Equus hemionus onager*) is endemic to Iran, also was once widespread across the region, but is today endangered (Hemami and Momeni 2013).

Carnivores

The Asiatic lion (*Panthera leo persica*) roamed the slopes of the Zagros Mountains up until the end of the 19th Century, and has only been officially extinct in Iran for about 50 years (Khosravifard and Niamir 2016). Another predator, active today, is the Persian leopard (*Panthera pardus tulliana*). Also favouring mountain forest, it likely faces similar modern threads as the wild goat. Another carnivore is wolf (*Canis lupus*) (Humphreys and Kahrom 1995; Firouz 2005).

Omnivores

Equally of increasing modern scarcity are the omnivorous Syrian brown bear (*Ursus arctos syriacus*) and Asiatic black bear (*Ursus thibetanus*). Other omnivores include wild pig (*Sus scrofa*), striped hyaena (*Hyaena hyaena*), jackal (*Canis aureus*), fox (*Vulpes vulpes*), Blanford's fox (*Vulpes cana*), jungle cat (*Felis chaus*), mongoose (*Herpestes ichneumon*), and marten (*Martes foina*). Apart from the bears, these mammals are today mostly found in the southwestern part of the Zagros (Firouz 2005).

Of further note is land tortoise (*Testudo graeca*), exhibiting a remarkable topographic and ecological distribution. In Iran they are found close to the shore, over dry open steppe, from hillsides to the high mountains above 4000 m.a.s.l. (Anderson 1979:514-516). In Iraq, mostly common in the grass-covered hills above the tree-line, they are reported from the Erbil area of Iraqi Kurdistan between 525-1785 m.a.s.l. (Reed and Marx 1959:115-116), and in the vicinity of Shanidar Cave (pers. obs.).

Additionally, five species of lizards are endemic to the Zagros (Anderson 1999). The mountains of northern and western Iran further provide breeding grounds for the lesser spotted eagle (*Aquila pomarina*) and the golden eagle (*Aquila chrysaetos*) (Anderson 1999; Firouz 2005).

2.2.2.2 Excavated faunal assemblages from Shanidar, Warwasi, and Houmian

Shanidar

Evins (1981, 1982) studied the macrofaunal assemblage from Shanidar Layer D (seasons I-III) of 1512 bones, with a number of identified specimens (NISP) of 1508, and a minimum number of individuals (MNI) of 134 (Evins 1982:40, Table 1). Including all deposits between 5.75-13.25 m. below datum, the material was divided into seven roughly 1 m. depths units (Evins 1982:38). Unfortunately, no horizontal information contextualising the excavator, Solecki's, squares or cuts are delineated. This lack of contextualisation makes any detailed comparison to stratigraphic units of lithics impossible. Evins (1982:53) did, however, find that the faunal composition was "*essentially homogeneous throughout the deposits*".

Wild goat (presumably the undomesticated subspecies *Capra aegagrus*) was the primary hunted animal at Shanidar by far (Evins 1982:42). Although the common difficulty of distinguishing between goat and sheep bones, which can obscure the actual division between the two taxa, and create the composite group "goat/sheep", also was an issue at Shanidar (Evins 1982:40, Table 1, and 43, Table 4), Evins (1982:48) concluded that "*goat contributed 90% or more to the caprine remains*". Evins (1982:48) based this conclusion on her analysis of MNI counts for goat and sheep, and inferred that "*sheep was relatively unimportant, either because the latter species was not culturally selected for or because it was not locally available in great numbers*" (Evins 1982:42).

Of the identified wild goat sample, some bones show evidence for burning, others either definite or possible cut-marks from butchering (Evins 1982:42). With C. *aegagrus* the primary meat staple at Shanidar (Evins 1982:45), land tortoise seems to have been the second most important source of sustenance (Evins 1982:46). Supporting this, tortoise and caprines are represented throughout the Layer D deposit (Evins 1982:46).

Secondary prey animals attested in small numbers are wild boar, red deer, roe deer, aurochs (*Bos primigenius*), and goitered gazelle. Evidence of wolf, fox and brown bear are also present (Evins 1982:40).

With a clear primary pattern of hunting wild goat, body part data for caprines indicate the "schlepp effect", suggesting wild goat was returned to site butchered (Evins 1982:48).

Evins (1982:51) argues that the age structure and mortality data suggest a death profile exhibiting a predominance of prime age adults. This, she claims, indicates a so-called 'catastrophic mortality', i.e. the mortality profile of the wild goat population is unsustainable (Evins 1982:53). Stiner (1994:297), however, states that ambush or stalking methods of hunting by predators over time can also create a faunal patterning focusing on prime age individuals similar to such as reported from Shanidar.

Evins (1982:53) find that the faunal composition at Shanidar is "largely a modern one", agreeing with Reed (Reed and Braidwood 1960) that the modern fauna is similar to the archaeological assemblages.

The above observations by Evins (1982) on faunal composition from Solecki's old excavations has been corroborated by preliminary observations made on the fauna excavated during the new excavations at Shanidar. The composition is predominately caprids with tortoise as the second most numerous species. Small carnivore and birds were also observed. Evidence of butchering marks on caprid remains were also supported (Marjolein Bosch, pers. comm.).

Warwasi

With only 31 identifiable bones and 86 teeth, the minimum number of individuals (MNI) of 15, recognisable for the entire Middle Palaeolithic sequence at Warwasi, is very low (Turnbull 1975: 154). Onager is the most common species (including 84% of the teeth sample), with wild goat/sheep also well represented. Although Turnbull (1975:145) specifically utilises the designation "*Capra hircus aegagrus*, wild goat"[sic], which technically specify the domesticated subspecies of wild goat, Uerpmann (1987) refers to the Warwasi caprine remains as ibex (see also Uerpmann in Heydari-Guran 2014:12, 145). Red deer and aurochs are also identified, as well as predators such as wolf and hyena (Turnbull 1975:154). Overall, this assemblage is described as "*meager and fragmentary*" (Turnbull 1975:143).

Turnbull's (1975) study of the faunal remains from Warwasi came to the conclusion that while the mammalian fauna of that part of the Zagros is similar in constitution to the modern-day fauna, based on the study sample, onagers appear to have been larger in size during the Middle Palaeolithic than in later periods (Turnbull 1975:152). As such, all recovered mammals, from throughout the sequence, Middle Palaeolithic through Epi-Palaeolithic, with exception of aurochs, are known to have been present in the region up into the 20th Century, or recent past (Turnbull 1975:152). This corroborates the study of land snails by Reed (1962) from in and around the rock shelter.

Although Turnbull (1975:141) asserts that "*field notes giving essential stratigraphic information*" were provided to her by the excavator, Bruce Howe, no stratigraphical information contextualising the faunal remains beyond culture-historical division (i.e. Mousterian, Baradostian, Zarzian) is presented. While some intermixing of layers is plausible based on the evidence for presence of rodents in the Mousterian layers (Turnbull 1975:147), later studies of the lithic assemblages (Tsanova 2013) argues that such disturbance, whether contemporaneously or further postdepositionally, seems to have not had a significant effect.

Tsanova (2013), in her taphonomic analysis for her techno-economic comparison of Early Baradostian lithic assemblages from Warwasi and Yafteh Cave, interprets Turnbull's (1975) findings of lack of evidence for red deer in post-Mousterian layers to be in agreement with her own findings of lack of lithic refits between the Mousterian and Early Baradostian levels. To her "*the taphonomic analysis demonstrates that the Warwasi sequence is mostly devoid of significant inter-level mixture*" (Tsanova 2013:49).

Houmian

Levine (in Bewley 1984:25-29) offers brief discussion and commentary on the faunal remains from Houmian comprising 159 bones and 189 teeth. Of these, 117 (73%) and 91 (48%), respectively, are from Layer 2a. The bones are very poorly preserved, described as fragmentary, fragile, and heavily concreted (Levine in Bewley 1984:25).

Regarding species, most are only identifiable within the Caprini tribe, but Levine (in Bewley 1984:27) found evidence for wild sheep, "*Ovis orientalis*", and assigns it as "urial sheep", although technically, that should rather be "*Ovis vignei*", as the former designates a mouflon (Hiendleder et al. 2002).

Wild goat, described as "Capra aegagrus *or* C. ibex, *wild goat or ibex*" (Levine in Bewley 1984:27).

Wild pig, red deer, and onager are also attested, as well as a hare (*Lepus* sp.), a cat (Felidae), and a vole (Microtinae). A larger species (presumed to be ungulate) is indicated but unidentifiable (Levine in Bewley 1984:25). The recognised species are all found in Iran today (Firouz 2005).

Within Layer 2a, 97% of bones are either goat/sheep or small ruminant. Unfortunately, due to the preservational state of the material, the minimum number of individuals (MNI) for this layer is 3 (based on teeth) (Levine in Bewley 1984:27). Levine (in Bewley 1984:27) considers the small MNI to not be indicative of the original number of carcases being brought to the site. Likewise, ca. 90% of the bone and teeth assemblage are from mature animals, but this is assumed to also be an artifact of preservation, due to the increased vulnerability of smaller bones (Levine in Bewley 1984:28). No evidence of non-human predators is found.

2.2.2.3 What might have been drawing hominins to higher altitude sites

Through the published material evidence of faunal assemblages in association with hominin stone tools, like the faunal assemblages outlined above, combined with theory based on ethnographic studies of modern hunter-gatherers (e.g. Kelly 1995) as well as exploration of human adaptability to various ecological habitats (e.g. Moran 2016), there is general agreement that Middle Palaeolithic hominin groups in southwest Asia not only were capable of hunting middle- to large-sized ungulates like ass, deer, goat, and pig in mountainous environments, but indeed did engage in it (e.g. de los Terreros et al. 2014; Yravedra and Cobo-Sanchez 2015; Luret et al. 2020).

It seems hard to repudiate the unambiguity of this earlier archaeological record, especially when it reflects patterns of human behaviour known from both later prehistory and ethnographic records, where a clear line depict human engagement with animals in the mountains from the Middle Palaeolithic to the present, including, at various times, hunting, domestication, pastoralism and transhumance (e.g. Rodionov 1994; Stiner 1994; Henry 1995; Zeder 1999).

Consequently, what seems to have been drawing hominins to higher altitude sites in the Zagros during the Middle Palaeolithic is hunting. This seems reasonably established by the faunal assemblages from Shanidar, Warwasi, and Houmian, representing dedicated hunting of wild goat, onager, and wild goat, respectively (Turnbull 1975; Evins 1982; Levine in Bewley 1984).

The fundamentals of animal ecology, where seasonal migration is involved or expected, usually assumes a seasonal movement across a relative distance. This movement is compelled by the need for continuous access to resources such as grass and water, and influenced by their changing availability forced by factors like temperature and rainfall (e.g. Henry 1994). This distance can be horizontal or vertical depending on species preferences and opportunities. For many species, this involves a spring movement up into hill or mountain pastures in search for summer grazing. While such summer exploitation of upland environments, with winter spent in lowlands, is common, it is by no means universally applicable for all the various types of species, in all times, in all environments (Geist 1971; Schaller 1977; Shackleton 1997; Phoca-Cosmetatou 2004).

Lindly (1997:65-90), in his study, based his reasoning for Middle Palaeolithic Zagros summer camps (e.g. Lindly 1997:79, 90) on a theoretical framework of modern land-use in southwest Asia, through his argued behavioural relationship between the socio-economic adaptation of the transhumance of 20th Century nomads and pastoralists, moving across the landscape with domesticated animals, and Pleistocene hunter-gatherers stalking wild pray.

Cementum increment analysis and seasonality

Of particular consequence for this study, and directly relevant to the assessment of the "Summer Adaptation Hypothesis", would have been access to data on seasonality of hunted fauna from the three Zagros sites, particularly the dominating groups of ibex and onager. Data on seasonality could potentially have shed light on what times of year, these animals were being hunted by hominins, thereby disclosing which seasons hominins were present in the highlands, and thus directly confirmed or refuted Lindly's (1997) hypothesis.

Seasonality can be inferred through so-called *cementum increment analysis*, which is the study of growth layers in dental cementum, which is the calcified substance covering the root of a tooth in mammals (e.g. Lieberman 1993; Sánchez-Hernández et al. 2019).

In contrast to non-dental bone, cementum does not go through continuous remodelling, but exhibits a layering-by-season growth pattern. For this reason, this particular tissue is extremely well-positioned to serve as a proxy for the changes occurring as the body invests in self-repair over the life-span of a given animal (Pérez-Barbería et al. 2020:1). As such, it becomes possible to determine the season-of-death and age-at-death of mammals (Prilepskaya et al. 2020).

Seasonality of ibex and onager

It is not the purpose of this thesis to endeavour to construct an argument disputing the reality of hominin exploitation of fauna in the Zagros Mountains during the Middle Palaeolithic summers. Rather, it is the purpose of this thesis to examine whether the phenomenon of the excavated Mousterian lithic assemblages associated with these faunal remains, is the result, *singularly*, as purported by Lindly (1997), of hominin movement up into, and exploitation of, mountain habitats during summer seasons only.

While Lindly (1997) rested his behavioural model of Middle Palaeolithic predator-prey interaction on an analogy founded on modern animal ecology (e.g. Geist 1971; Schaller 1977), the literature on the subject of seasonality and habitat-use of wild goat and onager, over the past few decades, has changed (Phoca-Cosmetatou 2003, 2004; Yravedra and Cobo-Sanchez 2015).

In particular, the Iberian ibex (*Capra pyrenaica*), a closely related species to the *Capra aegagrus* abundant at Shanidar and Houmian, has been shown in areas like Italy to have enjoyed a much broader geographical distribution during the Late Pleistocene (e.g. Phoca-Cosmetatou 2003, 2004), as opposed to strictly high altitude, as previously recognised (e.g. Couturier 1962; Schaller 1977). It is believed that the modern distribution is a product of anthropogenic pressure, and archaeological data has linked Late Pleistocene ibex to coastal, in addition to alpine, sites (Phoca-Cosmetatou 2003, 2004). Therefore, "*ibex should be considered a species with a wide tolerance to different altitudes*" (Yravedra and Cobo-Sanchez 2015:13).

Equally, Persian onager, attested at Warwasi, exhibits "*spatial and temporal variability in vegetation and habitat use*" (Nowzari et al. 2013:16). This has been demonstrated in observed onager-frequentation of hill-valley habitats during winter months, where neither age, sex, nor reproductive state seem to be a factor in this display of habitat-use. It is reasoned that the migration of onager into higher altitude valleys on windy or rainy days should be seen as a way to mitigate the bad weather, and larger sizes of observed herds are thought to be a way of increasing the amount of within-herd heat-insolation. Perhaps counterintuitively, "*onagers disproportionately aggregate on the plains during sunny days, typically during hot summer months*" (Nowzari et al. 2013:16).

2.2.2.4 Implications of focusing on technological sphere only

This thesis focuses on stone tools. The above sections summarise a brief description and discussion of aspects of the faunal sphere in general, as it can assist in providing context to interpreting hominin behaviour from lithic assemblages, and specific reference to the faunal assemblages from the three Zagros sites under study.

Due to the lack of associated contextual information available from these three faunal assemblages, specifically chronostratigraphically, with which to securely relate specific fauna to specific lithics, the faunal assemblages will not form any major part in the interpretative narrative of hominin behaviour in the Zagros Middle Palaeolithic pursued through the lithic assemblages, as it pertains to the examination of the "Summer Adaptation Hypothesis" in this thesis.

While climate, environment, and physiography (see Chapter 3) of course inherently affect the range of available game, it is, arguably, the increasing behavioural complexity, manifested in a proliferation of adaptational strategies, among hominins which makes for the variability seen in both lithic and faunal assemblages during the Middle Palaeolithic. In other words, it would appear that the existing degree of social organisation not only was enough for hominins to furnish adaptive solutions to ecological or socio-economic pressures but that they had the capability also to organize their lifeways accordingly. This can be gleaned through the closely related sphere of technology.

2.2.3 Technology

What really defines the Middle Palaeolithic in an archaeologically quantifiable way and sets it apart from the Lower Palaeolithic, is what appears to be an increase in lithic technological variability, unparalleled in human history up until that point (Shea 2013: 81). Across southwest Asia lithic typologies and reduction systems begin to exhibit regional variability (Garrod 1962; Skinner 1965; Copeland 1975; McBurney 1975; Nishiaki 1989, 2012; Meignen & Bar-Yosef 1992; Shea 1991, 1998, 2003, 2013; Lindly 1997; Meignen 1998, 2011; Hovers 1997, 2009; Hauck 2011, Pagli 2015) which must be assumed to be dictated, as in the Lower Palaeolithic, largely by function e.g. hunting, food procurement and processing, and raw material availability but now also, presumably, to a greater extent by diverse strategies of mobility and land-use, assumed to be evidenced by the lithic variability found (e.g. Kuhn 1995; Adler 2002; Riel-Salvatore and Barton 2004; Walker and Churchill 2014).

2.3 Levallois reduction as anticipatory behaviour in land-use strategies

The use of Levallois reduction is widely regarded to relate to hominin mobility, land-use, and raw material strategies, based on its affordances for supporting what has been argued to be curation as well as expedient exploitation, its volumetric conceptualisation argued to be beneficial for raw material economy, (Munday 1979; Geneste 1985; Geneste 1989; Boëda 1995; Hovers 1997; Hovers 1998; Shea 2003; Shaw 2012). Consequently, the technological and adaptive affordances of the Levallois technique often associate it with mobile toolkits (e.g. Wallace & Shea 2006).

2.3.1 Levallois points as spear points

The first evidence for the use of hafted stone tools, in the form of stone-tipped thrusting spears, is found in modern day Syria within southwest Asia during the Middle Palaeolithic (Boëda et al. 1996; Boëda et al. 1999; Boëda et al. 2008; Boëda et al. 2008; Hauck et al. 2013; Monnier et al. 2013). This adds another dimension to the use of Levallois reduction. The intensity of production and distribution of Levallois points through the Levantine Middle Palaeolithic (Meignen & Bar-Yosef 1992) has been argued to be closely related to variation in ecozones (Shea 1995). Through a correlation of lithic assemblages from a range of sites in the Levant it has been demonstrated that the frequency of occurrence of Levallois points is greater at sites within the Irano-Turanian steppe of the interior and southern Levant, than at coastal or Mediterranean woodland sites. This division in distribution fits well with the hypothesis developed by Shea (1988, 1991, 1993) of "*Levallois points as spear points*" (1995: 285), whereby the practice of, probably, either intercept or encounter hunting (*sensu* Shea 1998) of big game common to the interior steppes, like rhinoceros and wild boar, is proposed to have increased in response to possibly patchy vegetation and thus possibly fewer small herbivores (Shea 1995).

2.3.2 Levallois points – curated or expedient?

Points for spear tips needed to have been of particular dimensions in order to fulfil requirements of size as shown through experimentally knapped and tested Levallois points used in feasibility experiments associated with hunting (Shea 1991; Shea 1995; Shea et al. 2001; Shea et al. 2002; Sisk & Shea 2009). Through experimental knapping of Levallois cores (15 x 15 x 4 cm) Bradley (1977) found that with an arbitrary minimum size of 6 cm for a detached Levallois flake, it was possible to produce between 3-8 preferential flakes per core. Interestingly, through such a reduction process ca. 100 flakes (debitage) on average were additionally produced many of which could have been utilized for other tools e.g. scraper blanks (Bradley 1977).

However, while Levallois reduction might have been 'economical' in terms of raw material expenditure, there are reasons to believe that Levallois points might (at least at times) have been utilized as an expedient technology (Shea 1995: 286).

While feasibility experiments as mentioned above have shown the undeniable potential for Levallois points as spear armatures, their shape and often thin cross-section renders them inherently fragile which consequently furnishes them with relatively short use-lives (Shea 1995). However, as they could be easily made and replaced, transportation of Levallois points over long distances would not have been necessary (Shea 1995), given of course that the hominin knappers knew that where they were going raw material (or premade tools) would be available, and such locale could be reached before curated/transported tools or raw material had been exhausted.

The significance of this assumption is the possibility that Pleistocene hominins were capable of planning ahead and organising their mobility according to previously known locales. That such cognitive and technological affordances were available within Middle Palaeolithic social organization has been discussed by Gamble (1998, 1999), informed through theoretical approaches to landscapes in general (e.g. Ingold 1993). This is what Binford (1979: 258), through ethnographic analogy, has called to "*modify their effective environment*", and Kuhn (1995:22) has termed *provisioning places*. This seems to be corroborated in various studies of Middle Palaeolithic mobility and land-use through lithic technology (Cowan 1999; Wallace & Shea 2006; Daujeard & Moncel 2010), e.g. the way Conard & Adler (1997) engage with the issue of demonstrating contemporaneity through lithic assemblage resolution, thereby being able to present evidence for tool curation.

Accordingly, all this seems to support the possibility for anticipatory behaviour as a feature of Middle Palaeolithic hominin land-use strategies. The notion of 'planning' can be said to incorporate both the symbolic- and the faunal sphere, as well as the technological sphere. Central for Lindly's (1997) investigation into summer-seasonal exploitation was the combination of the faunal and the technological spheres, where the former informed the interpretation of the latter. While such influence is not disputed here, this thesis will focus on the technological sphere.

2.4 Background to site-use and artefact use-life

2.4.1 Typology vs. technology

Whereas most of the twentieth century had seen a methodological paradigm based on typological classification of retouched tools as indicators, or *guide fossils*, of where in a chrono-cultural organization a particular lithic industry should be assigned, a radical shift in approach emerged within its closing decades. Researchers started embracing a more holistic approach to the study of lithic artefacts that introduced the incorporation of debitage analyses through measurements of technological attributes (e.g. Collins 1975).

An early example of enquiry into the potential for behavioural interpretation based on debitage analysis is the work on French and Levantine Mousterian sites by Fish (1981). While still operating within a Bordesian paradigm, his focus on generating quantitative and qualitative data from debitage were informed by the recognition that this artefact group not only could contribute to behavioural inferences but could also provide information not available through formal tool type classification, and further, that such information could be obtained even in the absence of retouched artefacts: "*In such cases, it is apparent that without an interpretation of activities based on the analysis of debitage, there can be no interpretation at all*" (Fish 1981: 374).

By implementing a focus on technological attributes more complex questions could be engaged than were possible through typological classification alone. Instead of looking at static implements of culture a technological approach offers "*a dynamic view of tool life, and therefore allow a description of the strategies of use and discard*" (Sellet 1993: 109). This was exemplified though the development and wide adoption of the concept of *chaîne opératoire*.

2.4.2 Chaîne opératoire

Today, culture-evolutional inferences based on typological descriptions of lithic tool-types have been largely abandoned. The methodological revolution of the *chaîne opératoire* (operational sequence) approach, borrowed from French social anthropology and ethnology (Boëda et al. 1990; Sellet 1993; papers in Dibble and Bar-Yosef 1995) to the study of lithic assemblages within Palaeolithic archaeology (Geneste 1985; Boëda 1988; papers in Dibble & Bar-Yosef 1995) has changed the way researchers are able to approach aspects of socioeconomic organisation and adaptation within early human society. Specifically, within Middle Palaeolithic lithic analysis the *chaîne opératoire* approach was to a large extent formulated and operationalised through the study of prepared core reduction in the form of Levallois (Boëda 1988, 1994) (see chapter 4).

Studying the *chaînes opératoires* within a given archaeological context, Geneste (1989) proposed three analytical lines of enquiry related to the activities performed to produce the lithic assemblage: Refitting studies, experimental replication through knapping, and analysis of reduction sequences (diacritical study).

Within the present study, the predominantly fragmentary nature of the lithic assemblages, i.e. either the lack of certain parts of the reduction sequence or statistically insignificant amounts of material for some analysis, precludes any meaningful refitting studies. Replication studies have not been pursued due to constraints of time and skill. This thesis will, consequently, rely on a diacritical analysis of reduction sequences of individual lithics, by way of attribute analysis, as this element of the methodological scheme of Geneste (1989) is unconstrained by researcher knapping skills (or lack thereof), and is more effective than refitting, where assemblage resolution is poor. Overall, while the application of all three methods would be ideal, in most cases combinations of time constraints, lack of knapping skills, and poor assemblage resolution have seen researchers concentrating on the analysis of attributes through the study of reduction sequences. This study will follow that tradition.

Trying to define key aspects of hominin socio-cultural organisation in order to synthesise an understanding of long-term hominin behavioural adaptation is rarely straightforward. This is due to the timeframes involved, and the fact that material-culture samples usually come from already incomplete assemblages. These samples again come from just a small number of known sites, which themselves certainly constitute just a fraction of the original concentration. For this reason, such investigations require multiple levels of heuristic techniques.

2.4.3 Land-use

In trying to understand how early humans negotiated their survival, we have to appreciate how they organised their daily lives. As all hominins rely on food, water, and shelter, as well as the ability to manipulate material culture in the facilitation of these needs, the surrounding landscape necessarily will exert influence on these endeavours. Hominin land-use, therefore, is of great importance as a theatre within which to test certain hypotheses about hominin socio-economic organisation. Suggesting specific forms of possible use of a particular landscape as well as extent and period of exploitation is therefore necessary. Kelly (1995) suggested two modes of land-use strategies differentiated by intensity of mobility: forager and collector strategies (see also Binford 1980). The former assumes residential mobility, moving people to sources, whereas the latter has residential stability, organising provisioning by moving sources from the landscape to the place of residence.

2.4.4 Ethnographic analogy

Assuming that Late Pleistocene hominin land-use to some extent can be correlated with trends observed in historic contexts, Binford and others identified a number of features within modern hunter-gatherer societies, expressed through material culture, the parallels of which, if recognised in early human society material culture, could help translate those remains into behavioural information about land-use, mobility, and material culture management in the Middle Palaeolithic.

It has been argued by Lewis Binford (1977) that the presence of artefacts at a location is no evidence that they were actually used there and hence should not be summoned as proxies for particular site activity. Where resolution of the lithic assemblages allows it, the focus should rather be on individual *tool biographies* (Gamble 1999: 225-227) understood as a tool's complete *chaîne opératoire* or *use-life* (Kuhn 1990), *life-cycle* (Grimes and Grimes 1985) from manufacture, over use (including maintenance and curation/transportation) to discard. However, studies invoking the techno-functional insight of *chaîne opératoire* usually rely heavily on well excavated collections, i.e. assemblages retaining as complete a reduction sequence as possible. Where assemblages exhibit poorer resolution, reconstruction through *chaîne opératoire* necessarily becomes more speculative. In absence of sufficient richness within a lithic assemblage with which to re-construct the operational sequence(s) through technological observations, hominin behaviour may be considered through relying on tool-type frequencies as being related to mobility and landscape-use.

2.4.5 Site-use and artefact use-life

It has been argued by Bamforth and Becker (2000) and elaborated by Holdaway et al. (2004) that a general assessment of mobility and site-use is complex due to the possibility of the same site being reused over time. They hypothesize that differences in resources between areas, i.e. inconsistent distributions compared to more abundant distributions, should account for differences in assemblage variability. Consequently, the chances are better for long use-life artefacts being accumulated at localities recurrently being preferred for site-use. In areas with more evenly divided resources, it is argued to be unlikely for one site to draw mobile people more frequently than others, and the distribution of long use-life artefacts therefore will show a more uniform manifestation (Holdaway et al. 2004: 43). With the prominence of scrapers in the Zagros Mousterian assemblages it is worthwhile to remember the axiom-like prediction of Holdaway et al. (2004: 43) that "[*w*]*here an artefact is discarded is a function of its last use, however, where this last use occurred is a function of time*". The argument is that a long use-life tool will survive within a mobile toolkit for longer than short use-life artefacts. In this line of reasoning there is a greater chance that the 'expiration date' of the long use-life artefact will happen at a location occupied for a longer duration (Holdaway et al. 2004: 43). Such a notion is complicated by the concept of (tool) reuse. The possibility of a tool being reused after discard, either for the same task by another person, or, conceptualised as raw material, being turned into another tool (Hovers 2007), makes the distinction between 'primary', 'secondary', and 'tertiary', etc., discard potentially impossible to recognize. This techno-behavioural concept of primary, secondary, and tertiary "use" and "reuse" of tools, should not be confused with the terminology of techno-typological classification of stages of (unretouched) flake reduction.

In Binford's (1979) notion of *personal gear*, similar in vein to Kuhn's (1995) *provisioning of individuals*, heavily curated tools constitute an individual's standard hunting/gathering equipment. Based on ethnographic analogy such personal gear is repeatedly checked before every outing. Tools not in prime condition are repaired or discarded. This led Binford to argue that "*the discard of personal gear related to the normal wearing out of an item was generally done inside a residential camp, not in the field where the activity in which the item was used occurred*" (Binford 1979: 263). As this would seem to contradict Binford's (1977) earlier statement mentioned above that discarded tools do not disclose direct information about site activity, explanation through middle-range theory must be employed with caution and not assumed to be universally applicable (e.g. Tostevin 2013).

The discard threshold of long use-life artefacts like scrapers remains elusive (Holdaway 1991; Dibble 1995a; Shott 1995). Where it can be tentatively assumed that one successful excursion or hunting trip might quickly deplete the reduction potential of a Levallois core, it is more difficult to estimate how many butchering/secondary processing events it takes to wear out the working edge of a scraper, and further how many episodes of rejuvenation it takes before the tool is considered exhausted, and discarded.

It is the assumption that scrapers were used in the secondary processing of, for example, the hide of a killed animal. Since the actual kill presumably took place out in the landscape and not within a given cave, if the scraper were used inside a cave, the subject (e.g. a deer), or parts of it, on which it was used presumably must have been brought into the cave. Such behaviour of relocating from the locale of the kill to a locale of primary or temporary residence with parts of an animal is reported from open-air sites like Umm el Tlel in El Kowm in central Syria (Boëda et al. 1999; Boëda et al. 2001) and from the site of Far'ah II in the Negev desert (Gilead and Grigson 1984). Another problem with the reconstruction of site-use through assemblage composition has to do with the timescales involved when discussing the Middle Palaeolithic, specifically the effects of a changing environment, which, at least for southwest Asia, have been perpetually oscillating throughout the Pleistocene. Hence, a location receiving only limited site use for a period of e.g. a thousand years due to lack of resources caused by climatic conditions, could be expected to see an increase in use once such conditions improved. Consequently, whether a tool assemblage should be viewed as an expression of residential camp maintenance leading to discard or tool-specific use leading to exhaustion (and then discard), or indeed a mixture of both, might not be possible to assign a priori, but will have to be decided on a site-to-site basis.

2.4.6 From the Levantine Coast to the Zagros Mountains

Southwest Asia consists of numerous climatic, environmental, and physiographic zones, of which the Zagros Mountains, the focus of this thesis, is a part (see chapter 3). These zones have afforded different possibilities for hominin behavioural evolution throughout the Pleistocene (and beyond), with research history being shaped by research questions, as well as constricted by modern political structures (e.g. Frumkin et al. 2011; Dennell 2009; Demir et al. 2007; Goren-Inbar & Speth 2004; Bar-Yosef 1987). Because of the immense influence of early- to mid- 20th Century research history on knowledge production in this region, the creation of the Zagros Mousterian techno-complex, the focus of this thesis, is closely tied to the research history of especially the Levantine coast. In order to illustrate the reasoning for making inferences about material culture in the Zagros Mountains based on that from the

Levant, in the next part of this chapter, a short introduction to the research history and interconnectedness, through that research history, of the Levantine and Zagros regions will be presented. Specifically, the sites of Tabun and Ksar Akil will be highlighted. The former as the birthplace of the Levantine Mousterian, and the latter as my Levantine Mousterian reference site. The region of the Syrian steppe desert will also be presented, as an area between the Zagros and the Levant, as it is also heavily influenced by Levantine research.

2.5 The Levantine coast

2.5.1 Introduction

Few regions of the world have received more attention and intense debate than the Levant when it comes to Middle Palaeolithic research (for overview see papers in Wendorf & Marks 1975; Papers in Akazawa et al. 1998; papers in Hovers & Kuhn 2006; papers in Shea & Lieberman 2009; papers in Le Tensorer et al. 2011; Shea 2013). In particular, the Middle Palaeolithic lithic industry, known as the Levantine Mousterian, has been fiercely interrogated for more than a century. The reasons for this are many, including a favourable research history, and the question of modern human origins and dispersal out of Africa. As a continuation of the East African Rift system (Horowitz 1979), the Levant Rift system (Mart et al. 2005), dissects what is today the East Mediterranean Levant and has long been considered a corridor for hominin dispersals between Africa and Eurasia (Bar-Yosef 1987; papers in Mellars and Stringer 1989; Klein 1999; Bar-Yosef and Belmaker 2011; Bailey & King 2011; Shea & Sisk 2010; Richter et al. 2012; Bar-Yosef & Belfer-Cohen 2013). However, evidence is abundant that southwest Asia in general, and the Levant in particular, was sufficiently attractive for migrating hominins so as to leave behind a generous amount of cultural deposits.

When lithic assemblages from stratified cave sites have attained the prominence that they have it must be understood with reference to obtaining the objectives of what has been called the specific goal of archaeology, namely "*the documentation and explanation of long-term evolutionary changes in human behaviour, through its unique access to artefacts as the visible* *characteristics of these behaviours*" (Hovers 2009: 4). To this end the literal 'time-depth' represented by stratified cave deposits, sometimes combined with hominin remains, allowed researches to connect the evolution of stone tools to the evolution of early humans (Shea 2003). From early on a paradigm of culture-history was employed (Garrod & Bate 1937; Rust 1950; Neuville 1951) in order to explain the material-culture variability in an evolutionary framework.

Due to the many and early cave excavations the ever growing accumulation of lithic assemblages from the Levant made this area an analytical hotspot from where syntheses about hominin behavioural evolution were constantly created and revised (e.g. Copeland 1975; Bar-Yosef 1989, 1998; Shea 2013).

2.5.2 History of research

2.5.2.1 Tabun Cave

Between 1929-1934 Tabun Cave together with the neighbouring Es-Skhul and El Wad caves within the Wadi el-Mughara on Mount Carmel, became the target of one of the earliest scientific excavations in the Levant, indeed in all of southwest Asia (Garrod and Bate 1937). The discovery of what jointly represented a complete cultural sequence of stratified lithic assemblages comprising Lower through Epi-Palaeolithic industries, as well as hominin remains (McCown and Keith 1939) marked the beginning of a 'gold rush' of cave investigations (Turville-Petre 1927, 1932; Garrod and Bate 1942; Pervès 1945, 1948; Haller 1945; Rust 1950; Neuville 1951; Stekelis 1956) across the entire region.

On the basis of these investigations Garrod (Garrod and Bate 1937) arranged the excavated lithic assemblages in a chrono-stratigraphic framework. For the case of the Middle Palaeolithic three main units were established, Tabun Level D, Tabun Level C, and Tabun Level B. Levels D and C were attributed *Early Levalloiso-Mousterian*, Level B to the *Late Levalloiso-Mousterian*. The term "Levalloiso-Mousterian" had been adopted for the Levantine region by European scholars based on a proliferation of Levallois debitage seen in comparison with the Middle Palaeolithic of Europe (Shea 2013: 105). Copeland (1975) later proposed to make the Tabun sequence a regional yardstick for Mousterian assemblages throughout the Levant, renaming the layers Phase 1, Phase 2, and Phase 3. Renewed excavations at Tabun Cave conducted 1967-1972 (Jelinek et al. 1973; Jelinek 1981, 1982a, b) were able to substantially improve the stratigraphic control of the deep sounding, leading to an advanced reading of the various layers of the cave. This higher resolution rearranged Garrod's Levels B and C into Jelinek's Tabun Unit I, consisting of 28 beds. Level D was subdivided into 8 units (II-IX).

As the possibilities for absolute dating became more refined in the last decades of the 20th century (Grün, Stringer and Schwarcz 1991; Mercier et al. 1995), more secure dates could be extrapolated both within and between sites. However, as inconsistencies exist between the various techniques employed, dates for the same Middle Palaeolithic contexts within Tabun Cave currently range quite markedly. Accordingly, the earliest Level D ranges between 256±26 ka BP (Unit IX) (T33, T34, T36) to 196±21 ka BP (Unit II) (T18, T19, T20), Level C between 165±16 ka BP (Unit I) (T5, T8,T9, T10, T13, T14, T15) to 135 $^{+60/-30}$ ka BP (Unit I) (lab. codes not disclosed), and Level B between 104 $^{+33/-18}$ ka BP (lab. codes not disclosed) to 90 $^{+30/-16}$ ka BP (lab. codes not disclosed) (Grün and Stringer 2000; Mercier and Valladas 2003; Coppa et al. 2005; Ronen 2017).

As a consequence of the seminal value of the finds from Tabun Cave to the study of especially Middle Palaeolithic hominin techno-behavioural evolution, and because no other single cave sequence subsequently has been as influential to the overall study of this particular cultural period, Tabun Cave today is recognized as a 'type-site' for Middle Palaeolithic chrono-stratigraphic control in southwest Asia, and its sequence used as a yardstick for the comparative analysis of same period assemblages from new excavations across the whole of the region.

The 'Type-site' problem or the 'Tabun Taboo'

The problem with adhering to the idea, or paradigm, of the 'type-site' is of course that no one site will be able to accurately portray every single mode of socio-economic adaptation in a given area, let alone a region (Bisson 2000; Hovers 2009; Shea 2014). While this has been clear to researchers for some time, the lack of a chrono-stratigraphic alternative sees the same standard techno-typological comparison of Levantine Middle Palaeolithic assemblages to the Tabun sequence (i.e. Tabun B, C, or D) continue (e.g. Hauck 2011a, b). Though at the moment a necessary evil, this is of course extremely problematic as it potentially perpetuates a false impression of relationship, where in fact the reasons for perceived techno-typological similarity might be the result of completely dissimilar activities.

2.5.2.2 Ksar Akil

The rockshelter of Ksar Akil (also spelled Ksār 'Akil, Ksar 'Akil, Ksâr 'Akil, Ksar 'Aqil) is located ca. 10 km northeast of Beirut, above the coastal plain in the foothills of the Lebanon Mountains. The site is situated in the Antelias valley (Wadi Antelias), about 2-3 km east of the eponymous modern coastal town, originally somewhat upstream from a spring, on its upper (northern) of two branches, on the right (northern) bank, "*a stone's throw*" (Copeland 2000:78) from Antelias Cave on the southern branch, where also Abri Bergy is found (Ewing 1960:535). The Ksar Akil rockshelter faces south under a fine-grained Jurassic limestone cliff (originally ca. 50 m high from base/bedrock to top, but today almost entirely gone due to quarrying activity).

Containing an almost 23 m deep sequence encompassing Middle Palaeolithic to Epi-Palaeolithic facies, it is especially celebrated for its unique Upper Palaeolithic repository. Ksar Akil in many ways is to the Upper Palaeolithic what Tabun Cave is for the Middle Palaeolithic. It has an unparalleled stratigraphy spanning a famously rich progression of the transitions in the Upper Palaeolithic, from Initial Upper Palaeolithic (IUP), over Early Ahmarian, to Later Upper Palaeolithic, named *Ksar Akil Phase* 1, 2, and 3-6, respectively.

(Ewing 1947, 1948; Tixier 1970; Newcomer 1970, 1971; Azoury and Hodson 1974; Tixier & Inizan 1981; Azoury 1986; Bergman 1987, Ohnuma 1988; Williams & Bergman 2010; Douka et al. 2013; Bosch et al. 2015a, b).

The 23 m sequence commences with ca. 7 m of Middle Palaeolithic deposits. These deposits all, except for Level 26, have an alluvial signature which has been attributed to possible flooding by the Wadi Antelias (Wright 1951). Murphy (1939) noted thin black lenses of hearths within these layers. Intersected between the end of the Middle Palaeolithic deposits and the top of the sequence, three geological formations, known as "Stone Complex" 1-3 occurs. These are deposits of various expressions of sterile red clay and angular limestone pebbles. Stone Complex 3, 2, and 1 occur at 15 m, 10 m, and at 1.5 m, respectively, below datum. The stone complexes were thought by the excavators to be the result of natural *in situ* processes of limestone degradation and soil formation, and hypothesised as relating to environmental instability, possibly driven by increased rainfall (Braidwood, Wright and Ewing 1951; Douka et al. 2013: Bosch et al. 2015). This led to an interpretation of the three stone complexes as being correlated to wet sub-phases, or pluvials, within the Würm Glaciation (Braidwood, Wright and Ewing 1951).

Remains of two hominins, "Ksar Akil 1" and "Ksar Akil 2" (known as "Egbert" and "Ethelruda", respectively), were identified during excavations. The former, a juvenile *Homo sapiens*, is represented by a skull and postcranial remains found at 11.46 m below datum in an Early Ahmarian or Early Upper Palaeolithic context. The latter, represented by a partial maxilla, found associated with an Initial Upper Palaeolithic industry in level XXV at 15 m below datum, is today likewise thought to be anatomically modern human (Ewing 1947; Douka et al. 2013; Bosch et al. 2015).

While early investigations had recognised the site's prehistoric potential (Day 1926a, b; Delcourt 1927; Passemard 1927), the first controlled archaeological excavations began in 1937 through direct encouragement by the Abbé Breuil. They were directed by the Jesuit father Joseph G. Doherty, S. J., of Boston College, Massachusetts, a student of Dorothy Garrod at Cambridge University, herself a student of Breuil. Doherty was assisted by fathers Joseph W. Murphy, S. J., and George S. Mahan, S. J., fellow American Jesuit prists then of the Pontifical Biblical Institute of Jerusalem. From the 1938 season, J. Franklin Ewing, S. J., of Fordham University, New York, was attached as palaeontologist and anthropologist, and from the end of the 1947 season succeeded Doherty as director (Ewing 1947, 1948; Bergman and Copeland 1986:i-viii). Based on the published methodology and preliminary excavational and geological accounts (Murphy 1938, 1939; Ewing 1947, 1948; Wright 1951, 1962), it would seem standards, while naturally cruder than today, were in fact surprisingly advanced for pre- and early post-war fieldwork. The total combined number of artefacts are unknown, but in the 1937-1938 seasons close to 2,000,000 lithics and 1,000,000 faunal remains, were recovered (Ewing 1947:190). Through the 1937-1938 and 1947-1948 field campaigns, the excavation reached a depth of ca. 22.6 m (Williams and Bergman 2010:118) encompassing 37 levels, whereof 36 levels of cultural deposits were described and named I-XXXVI.

Ewing continued excavations at the site in 1947-1948 where both more rigorous sampling of artefacts together with developed stratigraphic control was introduced. The latter resulted in a revision of especially the later Upper Palaeolithic levels which were more than tripled from 8 to 27 (Douka et al. 2013).

Investigations at Ksar Akil were resumed between 1969-1975 by J. Tixier (1970, 1974; Tixier and Inizan 1981), who further enhanced the scientific methodology, introducing three-dimensional recording of artefacts, and was able to refine the stratigraphy even further.

While the earliest Middle Palaeolithic levels of Ksar Akil have still not been successfully dated, it is argued that these must predate 50 ka BP (Douka et al. 2013:4). The earliest absolute date available from the Middle Palaeolithic Level XXVIII, obtained through AMS on shell, is around 39.5 ka BP, with a modelled calibration used to estimate the end of the

Middle Palaeolithic occupation at 43.2–42.4 ka cal BP (Douka et al. 2013:4; cf. Bosch 2015a). Bosch et al. (2015a, b), through modelled AMS-dating on the marine gastropod *Phorcus turbinatus*, proposes a slightly earlier date for the IUP Level XXV at ca. 45,900 cal BP.

The Ksar Akil Middle Palaeolithic is ascribed to the levels XXXVI-XXVI, equivalent to a depth of between 19.4 and 15 m below datum, respectively (Marks and Volkman 1986; Douka et al. 2013: Supporting Information; Pagli 2013). Several consecutive reasons prevented the Ksar Akil Middle Palaeolithic assemblages from seeing publication for decades, and when it did Copeland (1975) like Ewing (1947) recognized it as Tabun Mousterian Phase 3/ Layer B, and possibly Phase 2/ Layer C.

Marks and Volkman (1986) sampled the top six Mousterian layers (XXVIIIB, XXVIIIA, XXVIIB, XXVIIA, XXVIB, and XXVIA) and subdivided them into Phase 1/Tabun D Mousterian (lower two) and Phase 2/Tabun C Mousterian (upper four), respectively. This division was made on account of techno-typological variation between the two phases. They further concluded that both a developmental break as well as a stratigraphic break is present between the Mousterian and transitional assemblages (layers XXV and XXIV) (Marks and Volkman 1986).

Lithic material from Ksar Akil will be used in this thesis for comparative purposes rather than material from Tabun Cave. The reason for choosing Ksar Akil material over Tabun, as a Levantine reference site, was due to accessibility, as the author was scheduling a research trip to the US east coast to work on Zagros assemblages at museums there, and the main Ksar Akil collection is stored in this area as well.

2.6 The interior Levant

2.6.1 Introduction

From east to west between the Zagros Mountains and the Levantine coast, a distance of some one thousand kilometres, stretches the interior Levant or Syrian steppe desert.

Compared to the coastal Levant and even the Zagros Mountains, the Palaeolithic of the interior Levant had received surprisingly little attention apart from a few early cave excavations.

2.6.2 History of research

2.6.2.1 El Kowm

In the heart of the arid steppic region of Syria, ca. 90 km northeast of the Palmyra oasis lays the area of El Kowm. A similar point of water in an arid region, fed by perennial natural springs, it constitutes a roughly 25 x 25 km wide plateau at an altitude of ca. 500 m a.s.l. (Jagher and Le Tensorer 2011). Confined in between the foothills of the Northern Palmyrides to the south and the Jebel al Bishri escapement to the north and east, the El Kowm oasis is argued to have constituted a veritable inland corridor between north and south (Jagher and Le Tensorer 2011: 204), through which countless groups of hominins have moved in pursuit of wild animals (Hauck 2010: 17-18). At El Kowm the topographical makeup drove herds of animals through this comparatively narrow gap, while geological affordances provided high quality raw material within the immediate hinterlands. Together with stable water sources this made for a near perfect place to ambush game attracted to these same springs. The archaeological record certainly seems to confirm this case as ca. 180 open-air sites have so far been identified in the area, dating from ca. 1 mya to ca. 10 kya (Le Tensorer et al. 2007).

Earliest explorations in El Kowm began in the mid 1960s (Buccellati & Buccellati 1967; Akazawa et al. 1970), but a systematic survey for Palaeolithic sites was not conducted until 1980 (Besançon et al. 1981). Over the next decade soundings (e.g. Hours et al. 1983) were also made at a few well sites which first and foremost illustrated an abundance of stone tools but also Pleistocene faunal remains related to the lithics (Hours et al. 1983; Copeland 1985). From around the start of the final decade of the 20th century excavations were launched at various sites in the El Kowm area, notably Nadaouiyeh Aïn Askar (Jagher 2000, 2011; Reynaud Savioz 2011), Umm el Tlel (Boëda et al. 2001), and Hummal (Le Tensorer et al. 2011). The latter two have so far produced astonishing information about the Middle

Palaeolithic period in this otherwise blank spot (Böeda et al. 2008; Lourdeau 2011; Hauck 2011a, b, 2013).

According to geoarchaeological (Le Tensorer et al. 2007), palaeontological (Morel 1996; Griggo 2000; Reynaud Savioz & Morel 2005), and palynological (Emery-Barbier 1998; Renault Miskovsky 1998) studies, the palaeoenvironment for all periods, including the Middle Palaeolithic, within the El Kowm oasis never surmounted sufficiently to fully improve from the arid to semi-arid environment (Jagher and Le Tensorer 2011) which still can be seen today.

Faunal evidence seems to corroborate this picture as the archaeological record shows abundant amounts of several groups of grazing herbivores (Griggo 2004). Prominently, camels are common within the El Kowm archaeological record, but also various kinds of antelopes and equids, together with large carnivores formed part of this steppic biotope (Jagher and Le Tensorer 2011).

The latest advances in chronometric dating of the sites of El Kowm have seen only some Later Middle Palaeolithic levels from Umm el Tlel and Hummal equipped with absolute dates (Böeda et al. 1996, 2008; Jagher and Le Tensorer 2011; Richter et al. 2011). At Hummal, however, issues with the specific dating technique employed have researchers putting emphasis on techno-typological associations with other Middle Palaeolithic sequences form sites in Southwest Asia, notably Tabun (Hauck 2011).

2.7 The Zagros Mountains

2.7.1 Introduction

The so-called *Zagros Mousterian* or *Southwest Asian Montane Mousterian* (Skinner 1965; Dibble 1984; Lindly 1997, 2005; Shea 2013) is a Middle Palaeolithic lithic industry assumed to be associated with warm period, summer occupations, or at least exploitation, of high altitude areas of the Zagros Mountains (Lindly 1997), but traces of the industry are reported widely from neighbouring regions such as Turkey (Otte 2008) the Caucasus (Golovanova and Doronichev 2003; Pleurdeau et al. 2007) and Iran (McBurney 1970; Mortensen 1993; Jaubert et al. 2009). While quintessentially "Mousterian" in appearance, i.e. having techno-typological similarities which would have made them look not immediately out of place in e.g. a Levantine or south-western France Middle Palaeolithic context, a specific and persistent variation has been claimed to divide this type of Mousterian industry from the neighbouring, and better known, southwest Asian Levantine Mousterian (Skinner 1965; Lindly 1997, 2005). The techno-typological hallmarks of the Zagros Mousterian and the characteristics which differentiate it from that of the Levant are illustrated to be the relative abundance of pointed and heavily retouched tools, in particular Mousterian points (Solecki and Solecki 1993) and scrapers (Dibble 1984a; Dibble 1984b; Dibble & Holdaway 1993). The reduction system favours comparatively short and non-laminar debitage (but see Dibble 1991: 248, 252) together with recurrent discoidal core preparation, and a focus on truncated-faceted-cores and cores-on-flakes (Dibble and Holdaway 10993; Shea 2013).

The different extent of utilization of Levallois technology observable between lithic assemblages has historically been one of the most noted differences between technological behaviour in the Zagros and the Levant (Coon 1951; Skinner 1965; Hole & Flannery 1968; Copeland 1975; McBurney 1975; papers in Olszewski & Dibble 1993; Lindly 1997; Hovers 2009; Shea 2013).

While initially described by Dorothy Garrod (Garrod 1962) the first comprehensive synthesis of the Zagros Mousterian was conducted by James Skinner (1965) as a regional comparative typological analysis between assemblages from Zagros and Levantine sites. Using assemblages from four Zagros sites as a benchmark (Shanidar Cave layer D, Hazar Merd Cave layer C, Bisitun Cave, and Kunji Cave) Skinner distinguished three groups: a Zagros Mousterian (Group A), a Yabroudian (Group B) and, a *Levalloiso-Mousterian* (Group C). Skinner recognised an east-west distinction between Group A and Groups B and C, and attributed this variability to "*early expressions of cultural traditions*" (Skinner 1965: 267). From this time onwards the Zagros Mousterian was understood as a distinct techno-complex though viewed as a somewhat techno-behaviourally inferior industry lacking the technological variability found in the Levant. But as Lindly (1997: 4) mentions "*the manufacture of these objects was a means to survival and, therefore, can inform us about this survival in a distinct way*", which is of course why the lack of variability in itself does not make the Zagros Mousterian any less interesting as an adaptive measure.

2.7.2 History of research

Archaeological research into the Palaeolithic of the Zagros was, with the exception of some early surveys, instigated by Dorothy Garrod in 1928 with her excavation of the caves of Hazar Merd and Zarzi (Garrod 1930). The site of Zarzi produced what is today recognized as a sequence of late Upper Palaeolithic and Epipalaeolithic layers (Wahida 1975; Conard et al. 2013; Tsanowa 2013). At Hazar Merd, Garrod uncovered both an Upper Palaeolithic and a Mousterian layer, and noted the similarity of the lithic assemblage of the latter with assemblages from the sites of Shukba and Zuttiyeh in Israel (Garrod 1930). Garrod also suggested cold period occupation of the cave based on burned lithics and faunal remains associated with hearths (Garrod 1930: 40).

2.7.2.1 Bisitun Cave

While Garrod eventually left the mountains of Kurdistan for the Levantine coast, the potential of the Zagros region for stratified cave sites, and therefore for the promise of long progressions of human evolutionary history, prompted Carlton Coon of the University Museum of Philadelphia to engage in a series of cave excavations from 1949 (Coon 1951, 1957). Most important among these were the results from Bisitun Cave, situated at ca. 1400 m a.s.l. in the vicinity of Kermanshah, Iran. The Mousterian industry found there had many features in common with the Hazar Merd (1200 m a.s.l.) assemblage (Lindly 1997: 12), but while hearths were prevalent at the latter site, no hearths were found at Bisitun. The analytical potential of the Bisitun lithic assemblage was, however, hampered by the selective curation strategy observed by the excavator (Lindly 1997: 12; Dibble 1984a: 24), an issue by no means unique to the Zagros but unfortunately particularly felt here due to the comparatively small number of excavated sites. From Coon's (1951, 1957) report on the Bisitun material, Skinner (1965) was aware of the quite selective curation of lithics employed, and later referred to it as a "unique" typology in his own re-appreciation (Skinner 1965: 59). Skinner (1965) nevertheless chose to place the Bisitun Middle Palaeolithic material within his Zagros Mousterian Group A, but was unable to appreciate the particular technological aspects later identified by Dibble (1984a). While Dibble agreed with the inclusion of the Bisitun assemblage within the Zagros Mousterian, he argued that the presence of truncated-faceted pieces and the high occurrence of Levallois technique, thus far not known from other Zagros Mousterian sites, challenged the stated homogeneity of the industry as a distinguished techno-complex (Dibble 1984a).

2.7.2.2 Barda Balka

In 1948, under the direction of Robert J. Braidwood, the Oriental Institute of the University of Chicago together with the American School of Oriental Research in Baghdad launched a major fieldwork project in today's Iraqi Kurdistan, known as the Iraq-Jarmo Project (Braidwood and Howe 1960). In 1951, the rockshelter of Palegawra in the Chemchemal Valley between Kirkuk and Sulaymaniyah was investigated and proved to hold a lithic industry analogous to the Zarzian (Braidwood and Howe 1960: 21). Also, the open-air site of Barda Balka was inspected, and test excavation produced handaxes, pebble tools, flake tools, and large flakes, which the excavators attributed to the Lower and Middle Palaeolithic. Unfortunately, though faunal and geological studies (Braidwood and Howe 1960: 61-62 and references therein) would seem to corroborate this claim, the lack of absolute dates, and the possibility of layers intermixing, Lindly (1997) argues for placing the material within the Middle Palaeolithic.

2.7.2.3 Warwasi

The Oriental Institute investigations crossed the Zagros into Iran with their "Iranian Prehistoric Project" in 1959-1960 where more sites were tested. In the Tang-i-Knesht Valley, close to the town of Kermanshah, excavation was carried out at the rockshelter of Warwasi and Kobeh Cave (Braidwood et al. 1960; Braidwood 1961).

Dibble and scraper typology

Warwasi yielded Zagros Mousterian, Baradostian, and Zarzian (Middle-, Upper-, and Epipalaeolithic, respectively) material (Braidwood 1961: 5-6; papers in Olszewski and Dibble 1993), but analyses of the lithic assemblages were not conducted until three decades later (Dibble & Holdaway 1993; Olszewski 1993a; Olszewski 1993b), by which time a total of 12,620 unworked flakes, knapping debris and various other categories of non-tools only were available through records, as this portion of the assemblage had been left at the site after being recorded (Lindly 1997: 187). Nonetheless, for the Mousterian assemblage Dibble and Holdaway (1993) were able, firstly, to contend the hallmarks of Skinner's (1965) definition of the Zagros Mousterian, by showing that also at Warwasi, as was the case at Bisitun (Dibble 1984a, b), Levallois reduction was more prevalent than first assumed, and secondly, that also at this site truncated-faceted pieces were represented. More far-reaching, it was suggested that the typological variability among scrapers is not grounded in typological templates or even dictated by task-specific purposes, but simply is a function of intensity of resharpening (Dibble 1984a, b, 1987). This could be demonstrated to be the case, not only at Warwasi but reflected in all Zagros Mousterian assemblages and indeed in Middle Palaeolithic assemblages throughout southwest Asia and beyond. This turned out to be extremely influential in the field of lithic technology (Dibble 1991, 1995; Dibble and Holdaway 1993).

Dibble suggested a revision of Bordes' typology (1961; Debénath and Dibble 1994) for the Lower and Middle Palaeolithic scrapers, where four main kinds – single, double, convergent, and transverse – were (and still are) generally recognized. Dibble argues that Bordes' typology does not account for the technology behind the morphology of a particular piece. Consequently, the amount and invasiveness of the retouch is a function of use, i.e. rejuvenation/maintenance, "*stages along a continuum of edge reduction*" (Dibble 1987: 109), not a predetermined stylistic or functional preference. In this light it could be assumed that while single side scrapers might have been produced *and* used at the site of excavation, heavily retouched transverse and *déjeté*/off-set side-scrapers more probably were brought into the site, used and, possibly, re-sharpened, there and then discarded. This high frequency of scraper resharpening is in notable contrast with the evidence from the Levantine Mousterian where scrapers are usually exhibiting a short use-life (Rolland & Dibble 1990), i.e. generally exhibiting lesser amounts of retouch.

Lindly's critique of Dibble's scraper typology

Lindly (1997), in the most recent synthesis of the Zagros Mousterian calls into question Dibble's (1984a, b, 1987, 1995) interpretation of scraper morphology as a function of retouch intensity based on analytical issues (Lindly 1997: 219-222). He claims that for the sample he analysed from the site of Bisitun, counter to Dibble's suggestion, "*no statistical significant difference or mean value in retouch intensity*" (Lindly 1997: 220) was found between single, double, and convergent scraper edges. What Lindly did find was that, apparently, retouch intensity values were not the same between the two edges on convergent scrapers but greater on one than the other, the other being equal in retouch intensity to double scrapers (Lindly 1997: 221). This discovery led Lindly to claim that unless both sides of such convergent scrapers are taken into consideration when using Dibble's model of reduction, that model would fail in its purpose of estimating reduction intensity. Further, if both sides of a convergent scraper *were* to be included in Dibble's model, the average index of reduction for a convergent scraper – at least those from Bisitun analysed by Lindly – would be the same as a double scraper, cancelling out any significant difference between the two classes of scrapers ((Lindly 1997: 222). To Lindly, this suggested that Dibbles's model fails to adequately explain the morphological difference among Middle Palaeolithic scrapers.

Uni- and Bi-directional cores vs. Centripetal/Levallois and Truncated-faceted cores

Another observation by Lindly's study addressed the distribution of different modes of core reduction among the Zagros sites. It appeared that a noticeable difference in distribution existed between uni- and bi-directional cores on the one hand, and "centripetal" (including Levallois) cores and "truncated-faceted cores" (what in this thesis is called truncated-facetted pieces) on the other, and that such difference in distribution could be shown to be dependent on site elevation. Uni- and bi-directional cores were more prevalent at lower-lying sites while "centripetal" cores and truncated-faceted pieces dominated at higher altitudes. Lindly argues this demonstrates a change in core-reduction strategy, with uni- and bi-directional cores being utilized at lower elevations and "centripetal" cores and truncated-faceted pieces at higher altitudes, for the purpose of extending raw material use-life (Lindly 1997: 264-265). This will be dealt with in later chapters.

2.7.2.4 Shanidar

At the same time as Braidwood and the Jarmo Project were investigating Palegawra, in Iraqi Kurdistan Ralph Solecki discovered and commenced excavation of the now famous site of Shanidar Cave in 1951 (Solecki 1952a, b, 1953a, b, 1955a, b, 1960, 1963, 1971, 1975; Solecki and Leroi-Gourhan 1961; Solecki and Solecki 1974, 1993). Comprising a multi-stratified deposit spanning the Middle Palaeolithic to the Neolithic, it was here the "Baradostian" Upper Palaeolithic industry was first recognized (e.g. Solecki 1963). Celebrated for its Neanderthal skeletons (Solecki 1953b; Trinkaus 1983), the finding of the renowned 'flower burial' (Solecki 1975) in particular established Shanidar as one of the most important cave sites in southwest Asia. Solecki's team pioneered the interdisciplinary palaeoanthropology of its time, for example by employing C14 dating to soil samples (Solecki 1955a). Results from these samples produced a date of 50 ka BP (C14 taken at the top of Layer D) (Sample GRO-2527), and more tentative trace element and pollen proxies estimated to 60-70 ka BP taken at 8.3m and 8.6m, respectively, for the Mousterian Layer D (Solecki and Leroi-Gourhan 1961: 736-737).

The success of these field seasons illustrated the immense potential of the site, of where an estimated 90% of the cultural deposits still remain untouched (Solecki 1963). Unfortunately, a fate suffered equally by most of the Zagros sites, the Shanidar material is still awaiting final publication. From the studies so far conducted on the lithic assemblage from the Middle Palaeolithic Layer D (Skinner 1965; Akazawa 1975; Solecki and Solecki 1993; Lindly 1997), it can be deduced that the Shanidar material techno-typologically does belong to the Zagros Mousterian.

With renewed fieldwork currently under way, new studies on issues of Neanderthal burial practices and Upper Palaeolithic technology are providing much welcomed data on this iconic site (Reynolds et al. 2015; Pomeroy et al. 2017, 2020a, b).

2.7.2.5 Houmian

In 1969 Charles McBurney organised the Cambridge University archaeological expedition to Iran (McBurney 1970). Originally envisioned "*to throw light on the expansion of the Upper Palaeolithic blade industries in South-West Asia, at the expense of the earlier Middle Palaeolithic flake assemblage*" (McBurney 1970: 185), due to circumstances beyond his control plans for studying cave sites in Eastern Iran were abandoned. Moving instead to the western part of the country, to the province of Luristan, caves known in the literature as "the painted caves" (Goff 1971; Remarcle et al. 2006), in the vicinity of the town of Kuh-i Dasht, 100 km south of Kermanshah, were chosen for investigation.

Four sites were explored, Mir Malas, Barde Spid and Houmian I and II, the former three through limited excavation. As Houmian II seems to have been only rudimentarily investigated and subsequently abandoned, and since finds from there do not seem to have been preserved (Bewley 1984: 3), the site of Houmian I will be referred to henceforth simply as Houmian. Houmian eventually turned out to be the only site of the remaining three with a Palaeolithic stratigraphy, the one week of excavation between 9th-16th August 1969, not only produced a lithic core and flake assemblage of 887 pieces (Bewley 1979), but also a faunal assemblage (Levine in Bewley 1984), a particle size analysis of sediments (Green in Bewley 1984), and a pollen assemblage, (Leroi-Gourhan 1980, 1981; Leroi-Gourhan in Bewley 1984).

McBurney knew that the material from Houmian would be significant in a discussion of the Zagros Mousterian and "*would seem to be of special interest as offering a high montane aspect of the Mousterian already known from such lower level sites in the same general region as Kunji, Yafteh, Bisitun, etc. It also offers possibilities of studying the evolutionary pattern of the Mousterian in the area*" (McBurney 1970: 186). Speaking generally about all four sites examined he offered the interpretation that: "*they probably indicate specialized summer encampments designed to exploit such animals of the high mountain environment as ibex, wild sheep, etc. A preliminary examination of the bones at least seems consistent with this suggestion*" (McBurney 1970: 186).

Houmian is a small rock shelter, measuring 25 x 8 meters (Bewley 1984: 12; or 20 x 5 meters, Bewley 1979: 1) situated high on a northeast facing limestone ridge above the valley from which it takes its name. Bewley (1979: 1), despite mentioning he never visited the site, assigns an elevation of "ca. 6000 feet amsl", (i.e. 1828.8 m) though throughout his later publication (1984) he specifically refrained, repeatedly, from giving a direct estimate of the altitude of the Houmian rock shelter, but rather, somewhat confusingly, alludes to the collection of rock shelters all being at the said elevation, as well as the top of the entire ridge being "up to 2000 meters" in altitude (Bewley 1979: 1). In this case, if the top of the ridge rises to an elevation of 2000 meters, the rock shelters necessarily must be at a lower. Leroi-Gourhan, in the same paper (Bewley 1984), in her contribution on pollen analysis, talks about the site being at an elevation of 1800 meters which presumably echoes Bewley's (1979) original estimate. Whether the vagueness of Bewley on the elevation of Houmian is deliberate in order to maximise the value of his argument is unknown. Unfortunately, however, Lindly in his later account (1997: 25-26) perpetuates Bewley's possibly inflated estimate of the site being situated at 2000 meters above sea level.

While this attention to detail might seem excessive, we must remember that the issue of elevation and altitude is one of the main topics of this thesis, as it relates to, impacts upon, and shapes the specific ecosystem wherein which a site is located. In this context, an increase or decrease of 200 meters represents a significant difference (e.g. Leroi-Gourhan 1981: 76; Leroi-Gourhan in Bewley 1984: 30).

Of specific interest, Houmian is one of the highest-lying Middle Palaeolithic sites in Western Asia (Roustaei et al. 2004) and has a single associated chronometric date (thorium-uranium on a piece of bone) of 148,000±35,000 BP, associated with Layer 2a (Bewley 1984:38). Although this date cannot be afforded too much significance due to its scientific age (ca. 1984), as also acknowledged by Bewley, it is interesting seen in concert with the pollen analysis done for the site, which placed Layer 2a around the Brørup Interglacial, then dated to 60-63 ka BP, but today is considered much older (see discussions in Chapter 3 and 9).

2.8 Chronology

2.8.1 Introduction

The main obstacle for high resolution syntheses of the behavioural and cultural evolution of hominins in the Middle Palaeolithic of the Zagros Mountains, since the dawn of scientific research in the area, has been the lack of a rigorous dating regime of radiometric dating (Garrod 1930; Coon 1951; Solecki 1955a, b, 1963, 1971; Skinner 1965; Bewley 1984; Dibble 1984a, b; Baumler and Speth 1993; Dibble and Holdaway 1993; Solecki and Solecki 1993; Lindly 1997; Roustaei et al. 2004; Heydari-Guran 2014; Reynolds et al. 2018; Pomeroy et al. 2020a, b).

This lack of a rigorous dating regime of radiometric dating has been due to a combination of spotted research history, and large-scale excavations mostly having been undertaken during the middle of the 20th Century, where radiometric dating was still in its infancy. Due to issues such as of the advances both of science and the culture-historical questions driving the evolution of archaeological knowledge production over the past century, what was once considered important might today be considered unimportant, as well as what was scientifically possible in the 1950s might today be considered of little scientific value.

Accordingly, while mid-20th Century large-scale excavations, utilising what were then state-of-the-art scientific techniques, did produce valuable material, most such sites in the Zagros lack chrono-stratigraphical control considered sufficient for modern-day analysis. For this reason, many of the Zagros Middle Palaeolithic archaeological collections exist today only as assemblages of lithics, usually accompanied with scattered faunal remains; both types of assemblages are often unable to be included in robust studies because of their lack of associated contextual data.

This has left today's investigations into Middle Palaeolithic hominin behaviour in the Zagros either to re-analyses of old collections of stone tools (e.g. Olzewski and Dibble 1993; Lindly 1997), or targeted, limited re-excavation of previously excavated sites (e.g. Reynolds et al. 2015, 2016, 2018; Pomeroy et al. 2017, 2020a, b). Both approaches are valuable for renewed understanding of hominin behavioural evolution, but are constrained by the choices made by the original excavators.

2.8.2 New dates for the Middle- to Upper Palaeolithic Transition in the Zagros

Over the last few years, studies on radiometric dating in the Zagros have been published (Becerra-Valdivia et al. 2017; Reynolds et al. 2018; Pomeroy et al 2020a, b), which, applied together with studies on relative chronology published over the last few decades (Bewley 1984; Dibble 1984a; Dibble and Holdaway 1993; Solecki and Solecki 1993; Lindly 1997; Tsanova 2013; Reynolds et al. 2018), significantly can help situate the Middle Palaeolithic of the Zagros in a chronostratigraphic framework.

While a lower radiometric boundary for the Middle Palaeolithic of the Zagros is still unknown, the upper boundary has recently been better understood. Attempting to uncover the timing of the elusive Middle- to Upper Palaeolithic Transition in the Zagros Mountains, Becerra-Valdivia et al. (2017) conducted AMS radiocarbon dating on archaeological samples from the sites of Kobeh Cave, Kaldar Cave, and Ghār-e Boof in the Iranian Zagros, and utilised previously published radiocarbon determinations from Yafteh Cave in Iran and

Shanidar Cave in Iraq. Shanidar and Kaldar caves contain both Middle and Upper Palaeolithic material; Ghār-e Boof and Yafteh only Upper-, and Kobeh only Middle Palaeolithic (Becerra-Valdivia et al. 2017).

Using the previously published radiocarbon determinations from the two latter sites, it was possible to statistically model and improve their chronological resolution, presenting the prospect of comparing those results with the three fresh data sets. Through Bayesian modelling, a proposed date of 45,000-40,250 cal BP (68.2% probability), as commencement of the Upper Palaeolithic, puts this as a *terminus ante quem* for the Middle Palaeolithic in the Zagros (Becerra-Valdivia et al. 2017:57). These dates are slightly later than the timing of this transition in the Levant (Bosch 2015a, b; Hershkovitz et al. 2015; Alex et al. 2017), and roughly similar to dates from this transition in Europe (Nigst 2012, 2014; Fewlass et al. 2020).

2.8.3 Consideration of chronology for sites being discussed

2.8.3.1 Shanidar

Chronology from the old excavations

Shanidar Cave has a multi-layered stratigraphy traditionally divided into layers A-D. Layer A contains Holocene Neolithic industries and is radiocarbon dated to 7,000 BP to recent (Solecki 1971). Below, Layer B is split into B1 and B2, which are both of the Epipalaeolithic Zarzian tradition, with Layer B1 including a group of burials. Layer B1 is radiocarbon dated to 10,600 ± 300 BP (W-667) (Solecki 1963, 1971), and Layer B2 is radiocarbon dated to 12,000 ± 400 BP (W-179) (Solecki 1963, 1971). Underneath the Zarzian, Layer C comprised the eponymous Baradostian Upper Palaeolithic, which was radiocarbon dated between 28,700 ± 700 BP (W-654) (top) and 35,080 ± 500 BP (GrN-2549) (bottom) (Solecki 1963). Another 7 radiocarbon dates within these ranges were published (Solecki 1955a; 1963; Vogel and Waterbolk 1963:173; Hole and Flannery 1968:153; Becerra-Valdivia et al. 2017:62). The lowermost lithic industry found was identified as Middle Palaeolithic Mousterian, radiocarbon dated between 50,600 ± 3000 BP (GrN-1495) (Vogel and Waterbolk 1963:173; Hole and Flannery 1968:153), and 46,900 ± 1500 BP (GrN-2527) (Solecki 1963; Vogel and

Waterbolk 1963:173). Solecki noted that an apparent hiatus of ca. 10,000 years was discernible between the end of Layer C and the start of Layer D (Solecki 1971: 256). Solecki also noted that with an assumed constant rate of sedimentation of ca. 38 cm per 1000 years, the beginning of the Mousterian accumulation of Layer D could be estimated at ca. 100,000 years ago (Solecki 1963:185).

The remains of the 9 Neanderthals identified at Shanidar by Solecki (1961, 1963, 1971) originally were grouped into two separate periods within Layer D, based on stratigraphic provenance (Solecki 1971). Shanidar 1, 3, and 5 were included in one group, and Shanidar 2, 4, 6, 7, 8, and 9 were included in the other (Solecki 1971). Lately, Shanidar 10 (Cowgill et al. 2007) was added to the latter group. The former group was dated to ca. 50,000-46,000 BP, and the latter group to between ca. 100,000-60,000 BP (Solecki 1971; Cowgill et al. 2007), although it must be remembered that the lower limit of 100,000 BP is an extrapolation and not a radiometric date (Solecki 1963:185).

Dates from the new excavations

Within the last few years, the new excavations at Shanidar have provided some clarifications on the dating of some of the Upper and Middle Palaeolithic sub-layers within Solecki's layers C and D (Reynolds et al. 2015, 2016, 2018; Pomeroy et al. 2017, 2020a, b). Specifically, we have reported preliminary radiocarbon dates of ca. 42,000–35,000 cal. BP from the main Baradostian levels, exposed by the new excavations (Reynolds et al. 2018: 745).

In 2015, this author and colleagues by chance uncovered Neanderthal bones ca. 5 m below the cave floor within Layer D. Through various analyses they were confirmed as belonging to Shanidar 5 (Reynolds et al. 2015, 2016; Pomeroy et al. 2017). New radiocarbon and OSL dates essentially confirm Solecki's old dates for this group (Shanidar 1, 3, and 5) at ca. 55,000-45,000 BP (Pomeroy et al. 2020a: 13).

Part of the second group of Neanderthal individuals, located within close stratigraphical proximity, are what is known as the Shanidar 4/6/8/9 cluster, of which Shanidar 4 is the famous 'Flower Burial' (Leroi-Gourhan 1975; Solecki 1975; Pomeroy et al. 2020a, b). In the 2017 and 2018 fieldwork seasons, new Neanderthal remains of an articulated skeleton within that cluster was uncovered at ca. 7 m below the cave floor (Pomeroy et al. 2020a, b). The preliminary indication of the OSL dating is that the new remains, likely together with the entire Shanidar 4/6/8/9 cluster (today interpreted as intentional burials), date to between 70,000-60,000 BP (Pomeroy et al. 2020a: 22). The tentative assumption based on these findings is, that such Neanderthal burial practice can be said to have been performed, at least intermittently, for at least 20,000 years from ca. 70,000 to ca. 50,000 BP (Pomeroy et al. 2020b: 274). These new radiometric dates extend the absolute chronology, initiated by Solecki's fieldwork, back ca. 10,000 years from ca. 60,000 BP to ca. 70,000 BP for Layer D4a.

2.8.3.2 Warwasi

No radiometric dates exist for Warwasi (Dibble and Holdaway 1993). Recent attempts at extracting collagen for radiocarbon dating from bones of faunal remains from the Warwasi assemblage has unfortunately been unsuccessful due to the preservational state of the material (Tsanova 2013: 42, Note 3).

2.8.3.3 Houmian

Radiometric date

Only one radiometric date was obtained from Houmian and published by Bewley (1984:38, Note 53). It is a thorium/uranium date of 148,000 ± 35,000 BP from a bone fragment. The bone came from Cut C2, Spit 2, Layer 2a. Unfortunately, bone is not ideal for thorium/uranium-dating (Schwarcz 1992:61), as the process of uranium accumulation, happening postdepositionally during bone diagenesis, distorts the dating signal (Hercman 2014:4). Although successful, accurate, dating of bone through thorium/uranium today is considered "*quite realistic under certain conditions*" (Starikova et al. 2019:5), four decades of scientific fine-tuning of this method, after the dating of the Houmian bone fragment, proves its utilisation on bone, even today, is less than straightforward. Consequently, taken at face value, the thorium/uranium date of 148,000 BP would place Layer 2a in the MIS 6 glaciation (191,000-130,000 BP). However, with a wide error range of 35,000 years, a date further back in MIS 6 or, conversely, in the middle of the MIS 5 Interglacial (130,000-71,000 BP) is possible. The latter possibility, a MIS 5 date, would seem to be suggested by the palynological study, which will be discussed below.

Palynology

Leroi-Gourhan (1981; in Bewley 1984:30-32), studying the palynological samples from the Houmian stratigraphy, observed that "*Layer 6 is particularly cold and dry … In* [Layer] *5, a very slight improvement is observed but, from 4b to the bottom of 2a, cold steppe is altogether dominant*" (Leroi-Gourhan in Bewley 1984:30). Leroi-Gourhan (in Bewley 1984:30) goes on to identify a "*considerable climatic fluctuation*" at the end of Layer 2a, specifying that it "*points to a period of a certain humidity* … [and] *implies a sharp rise in temperature*."

Leroi-Gourhan (1981; in Bewley 1984:30-32) placed the main occupational Layer 2a in the Brørup Interstadial, which was at the time dated to 63,000- 60,000 BP. Leroi-Gourhan (in Bewley 1984:32) extrapolated from this an overall date of 70,000-60,000 BP for the "*upper part of the Mousterian industry*" at the site. Today, however, the Brørup Interstadial is better known as Marine Isotope Stage 5c, now dated at 105,000-95,000 BP (peak ca. 96,000 BP) (Lisiecki & Raymo 2005) or 109,00-96,00 BP (Räsänen, Auri and Ovaskainen 2021) (see discussions in Chapter 3 and 9).

2.8.3.4 Ksar Akil

As mentioned above, material from the Levantine Mousterian site of Ksar Akil will be used in this thesis for the purposes of a comparative study. While the chronostratigraphy of Ksar Akil is still not fully dated, absolute dates exist for the earliest Upper Palaeolithic (IUP) layer XXV(25), and the second youngest Mousterian Layer XXVIB(26B). The earliest Upper Palaeolithic layer is dated through AMS radiocarbon at 45,900 cal BP (Bosch et al. 2015a, b), or at 43,200–42,400 cal BP (68.2% prob.) (Douka et al. 2013), also through AMS radiocarbon. The second youngest Mousterian layer XXVIB(26B), immediately below, is dated by a uranium-thorium determination to ca. 47,000 BP (Van der Plicht et al. 1989).

Douka (2013:4) argued that the earliest, or 'basal part', of the Mousterian layers at Ksar Akil, while "*effectively unknown … probably* [are] *greater than 50 ka BP*". This seems to be quite a conservative estimation of 7 meters (16-23 m) of Middle Palaeolithic site use accumulation, especially when compared to the dating by Bosch et al. (2015a, b) which puts the start of the IUP at almost 46,000 BP. That would leave only 4000 years for layers XXVIA(26A)-XXXVI(36), which, while not impossible, seems unlikely.

2.8.4 Consideration of inter-site chronology for site selection and comparison

Because many of the published Middle Palaeolithic assemblages from the Zagros Mountains suffer from a combination of old, unreliable radiometric dates as well as issues with stratigraphic integrity, inter-site comparative studies in this region is complicated. Below I will argue the case that the sites of Shanidar, Warwasi, and Houmian are chronologically comparable based on available radiometric dates, as well as through techno-typological affinities, and, therefore, that the lithic assemblages from the three sites presented here can be reliably compared.

Where the chronostratigraphy for the Levantine Mousterian techno-complex in the Levant has a better resolution due to a more rigorous radiometric dating regime (e.g. Akazawa, Aoki and Bar-Yosef 1998; Shea 2013; Enzel and Bar-Yosef 2017), the chronometric framework associated with the Zagros Mousterian is more loosely based on a combination of lithic techno-typology, environmental proxies, and a limited number of radiometric dates from the 20th Century (Skinner 1965; Dibble 1984a, b; Olzewski and Dibble 1993; Lindly 1997; Tsanova 2013).

For this reason, any inter-site comparisons of Middle Palaeolithic Mousterian lithic assemblages from the Zagros Mountains need to be sufficiently justified through a demonstration of relative chronological contemporaneity between the respective sites in order to be acceptable analytically.

In order to assert such inter-site chronological contemporaneity, the limited available absolute dating of the three Zagros sites chosen for study in this thesis will be compared, and augmented by published analyses of their relative place in the Zagros Middle Palaeolithic chronostratigraphy based on lithic assemblages.

2.8.4.1 One or more adaptive strategies?

Regarding the question of whether more than one adaptive strategy is manifested in the Zagros assemblages, and thereby affecting the possibility of defining a singular behavioural model materialised as a lithic techno-complex, it is important to call to attention a main issue fundamental to Lindly's (1997) study of the Zagros Mousterian.

Whether or not the Middle Palaeolithic assemblages found in the Zagros represent one or more adaptive strategies, they are still defined (first by Skinner (1965), then by Lindly (1997)), and perpetuated in the literature as being endemic to the Zagros (Hole and Flannery 1968; Smith 1986; Baumler and Speth 1993; Dibble and Holdaway 1993; Heydari-Guran 2014) and further being an expression of summer-seasonal high-altitude exploitation (Roustaei et al. 2004:694-695; Rose 2010:857).

It is exactly the purpose of this study to consider how confident we can be that not more than one adaptive strategy is expressed in the Zagros data, or alternatively, whether sufficient homogeneity exists to uphold the Summer Adaptation Hypothesis.

Based on the premise driving Lindly's (1997) study, namely that hominins followed their prey animals up into the mountains each summer, and based on the conclusion drawn from his lithics analysis, that the Zagros Mousterian is a (single) summer-seasonal adaptation geared towards hunting in an environment of raw material stress, this thesis follows the line of reasoning employed by Lindly (1997).

Lindly states:
"*Seven sites were chosen for study due to their prominence in the characterization of the Zagros Mousterian and because of the accessibility of the collections. These sites are Barda Balka and Shanidar in Iraq, and Bisitun, Warwasi, Kobeh, Kunji, and Gar Arjeneh in Iran*" (Lindly 1997:171).

Consequently, since Lindly (1997) argued these sites were comparable mainly based on their techno-typological affinities, and resigned to the fact that sufficient radiometric data was not available (Lindly 1997:62-64), this thesis will deal mainly with the analysis of those techno-typological affinities within the lithic assemblages chosen for this study.

It must be highlighted that Lindly (1997) successfully argued for the presence of a summer-seasonal settlement-subsistence pattern, and explained it through an adaptational model of stone tool use, where he persuasively argued for its homogeneity and verified it as a techno-complex (Skinner 1965; Lindly 1997).

Lindly's point is that the "Zagros Mousterian" is a summer-seasonal adaptation. The chronological contemporaneity between the site assemblages he discusses seems to be of secondary importance based on, firstly, his confidence in all assemblages being Middle Palaeolithic Mousterian, and, secondly, that they were all discarded/deposited during summertime.

Lindly states:
"The relationship of the different Mousterian lithic industries in the Levant becomes even more muddled. For example, the duration that some of these industries were produced has become on the order of a minimum of 80,000 years … The lack of change and variability in reduction strategy is difficult to explain if viewed in terms of the changing environment as documented by isotope stage 6

through 4 when the environment shifts from cold to warm and back to cold again. The perseverance of Tabun D type industries … also suggests a longevity of this technology heretofore never suspected. The Zagros Mousterian industries could well be as long lived" (Lindly 1997:62-63).

For this reason, being able to test Lindly's (1997) postulation regarding the Summer Adaptation Hypothesis requires an assumption that the sites are comparable, based on their techno-typological affinities and high altitude locations. For this reason, the boundaries of the framework he constructed to test his own model allows for a similar degree of chronological range as seen in the Levantine Mousterian. As such, the Levantine Mousterian techno-complex is accepted as an entity, despite the fact it covers a more than 200,000 year period. Likewise, Lindly's (1997) model encompasses this chronological range for the Zagros Mousterian.

2.8.5 Consideration of chronological contemporaneity between assemblages

Previous studies (Dibble 1984a, b, 1991; Dibble and Holdaway 1993) have argued for the acceptability and appropriateness of the identification of a distinct Zagros Mountains Mousterian techno-complex within the Middle Palaeolithic of southwest Asia, as originally proposed by Skinner (1965). Others (Bewley 1984; Baumler and Speth 1993; Yalçinkaya et al. 1993; Roustaei et al. 2004; Tsanova 2013) have built upon this framework of a Zagros Mousterian, while Lindly (1997) made the case to cement its position as a specific summer-season adaptational strategy for high-altitude environment exploitation.

While the assemblages are all unquestionably Middle Palaeolithic Mousterian, both their typological appearance and technological expression set them apart from the Levantine Mousterian (Dibble 1984a, b, 1991; Baumler and Speth 1993; Dibble and Holdaway 1993; Solecki and Solecki 1993; Lindly 1997; Shea 2013; Tsanova 2013). As mentioned above, the Zagros Mousterian is described typologically as exhibiting smaller blanks and tools, relative to the Levantine Mousterian, and being more intensively retouched. Technologically, this manifests as a focus on scrapers and points, with flakes being reused as cores as a way of managing stone raw material shortage in an environment less rich in stone raw material than the Levant.

2.8.5.1 Shanidar

The lithic material from Shanidar used for analysis in this thesis (see Chapter 6), comes from sub-layers D4a, D4b, and D4c in Solecki's squares D-7 and D-8 (See figures 62 and 67). These sub-layers are each ca. 1 meter in depth (Solecki and Solecki 1993:121). Within each of these sub-layers various spits containing lithics are defined. Not all spits from sub-layer D4c were included (see Chapter 6), limiting the vertical stratigraphy of the utilised material from sub-layers D4a, D4b, and D4c to ca. 2 m from ca. 7 to ca. 9 meters below datum.

Although this thesis uses lithics from squares D-7 and D-8, and the new dates for the Shanidar 4/6/8/9 cluster comes from Square B-7, the relative proximity of these squares would suggest a *terminus ante quem* of 70,000-60,000 BP, through horizontal correlation, for the top of sub-layer D4a in Square D-7. This would mean that the lithic assemblage used in this thesis must have been deposited around or before 70,000-60,000 BP. While it can be precarious to extrapolate too much from this new radiometric date, two tentative suggestions can be made.

The first suggestion is that with the radiometric dates available, it does appear that the rate of sedimentation to some extent follows the actual depth in meters of the stratigraphy. With dates of ca. 40,000 BP from the bottom of the Baradostian at ca. 4 meters, ca. 55,000-45,000 BP for the Shanidar 1, 3, and 5 remains at 5 meters, and 70,000-60,000 BP for the Shanidar 4/6/8/9 cluster at ca. 7 meters, the 2 meter deposits of sub-layers D4a, D4b, and D4c, used in this thesis, at depths of 7-9 meters could be tentatively argued to be given extrapolated dates of 90,000-70,000 BP. This is of course highly speculative.

The second suggestion is the possibility that the cultural deposits around 7 meters depths were comparatively richer than other deposits within the Layer D stratigraphy, as suggested by Solecki and Solecki (1993:146). This could mean that 1 meter of deposits here represents either many thousands of years, or, on the contrary, represents accumulations from a much shorter, relative, duration of site use, in which case the above simplistic correlation of depth and age cannot be accepted. In this second scenario, it could be argued that sub-layers D4a, D4b, and D4c could have been deposited between 70,000-60,000 BP.

2.8.5.2 Warwasi

The Warwasi Middle Palaeolithic deposits (see Chapter 7) are located at the base of the sequence, from spits CCC-NN, comprising 1.8 m of sediment (Dibble and Holdaway 1993; Olszewski and Dibble 1994).

With no radiometric dates for these Middle Palaeolithic deposits, Heydari-Guran and Ghasidian (2020:3-4) suggests that: "*In the lack of absolute dating on important sites like Warwasi Rockshelter … lithic techno-typological analysis evaluates the periods of occupations in the site*."

As mentioned previously, a taphonomic analysis based on observations of inter-level lithic techno-typological and faunal composition, suggested no signs of inter-level mixing between the Middle Palaeolithic and Upper Palaeolithic, and thereby provides an argument for the relative integrity of the Mousterian lithic assemblage (Tsanova 2013:47).

Besides establishing the case for inter-level integrity of the deposits, Tsanova (2013:54) also argues on lithic techno-typological grounds for a continuity of lithic traditions from the Mousterian into the overlying Baradostian. That this is not a question of mixing is evidenced by the absence of refits between the two cultural periods (Tsanova 2013:55). There is further no evidence for a hiatus between the Middle and Upper Palaeolithic levels (Tsanova 2013:60).

Based on her extensive study on the lithic material from Warwasi and Yafteh Cave, Tsanova (2013:62) proposes that the Baradostian assemblages from these two sites are contemporaneous. Combined with the new chronometric investigations of the Middle- to Upper Palaeolithic transition in the Zagros Mountains using radiocarbon dating and Bayesian modelling, the date boundary of 45,000-40,250 cal BP proposed by Becerra-Valdivia et al. (2017) would effectively date the start of the Warwasi Upper Palaeolithic by proxy of techno-typological correlation to the Yafteh Baradostian.

Beyond an extrapolated, albeit convincing, end date of 45,000-40,250 cal BP, it is not currently possible to reliably date the Mousterian occupation at Warwasi. However, the suggestion that no hiatus exists between the end of the Mousterian and the start of the Baradostian, indicates that the latest Mousterian could be dated at ca. 45,000. The two spits chosen for analysis in this thesis, spits 'WW' and 'XX', are located at ca. 95-115 cm below the transition between the Upper Palaeolithic Spit 'LL' and the Middle Palaeolithic Spit 'NN' (apparently no spit 'MM' was utilised (Olszewski and Dibble 1994:68-69; Tsanova 2013:42)). Through more extrapolation, it seems not unreasonable to tentatively assign a cautious, conservative date of 55,000-45,000 BP (MIS 3), for these two spits of the Warwasi Middle Palaeolithic, although the material could well be of MIS 4 or even MIS 5 age.

2.8.5.3 Houmian

Radiometric date

Commenting on the relatively old determinations of the radiometric dates (i.e. MIS 6 to MIS 5), published for Zagros Mousterian assemblages from the sites of Houmian (148,000 ± 35,000 BP) (Bewley 1984) in the Zagros, and Karain Cave (130,000-60,000 BP) (Yalçinkaya et al. 1993; Otte et al. 1995) in the Taurus Mountains, Lindly (1997:53) acknowledged that not all sites containing Zagros Mousterian assemblages are contemporaneous. He did not, however, see that as an excluding factor for his behavioural model of high-altitude land-use. This is expressed through his repeated comparison of Houmian and Shanidar, although the lithic material of the former site is not included as part of his study assemblages (Lindly 1997: 18-19, 25-27, 37-39, 43-47, 50-53, 63-64, 268-269, 313).

According to Lindly (1997:63-64), since the radiometric dates for the Levantine Mousterian in the Levant are comparable to similar ("Mousterian") deposits in Europe and Africa, the dates from Houmian and Karain Cave suggest the same is true for the Zagros and Taurus mountains.

At Karain Cave, deposits within the Middle Palaeolithic stratigraphy have been dated from 130,000 to 60,000 BP, with specifically 'Complex G' being "*similar to the Zagros Mousterian*" and dated to 130,000 to 110,000 BP (Otte et al. 1995:290-291).

This would make Houmian not an outlier, but merely in the older range of the Zagros Mousterian tradition, likely dated, together with Karain Cave, to the Last Interglacial. Since Lindly (1997) does not discriminate between potential Zagros Mousterian assemblages (be they of interglacial or glacial age), this study should not exclude them either.

Palynology

Leroi-Gourhan's palynological study (1981; Leroi-Gourhan in Bewley 1984) (elaborated upon in Chapter 9) offers some important insights to complement the assertion of interglacial age for Houmian.

Although both the radiometric- and the palynology-derived date from Houmian should be viewed with caution, their relative convergence around MIS 5d and MIS 5c is interesting.

Leroi-Gourhan (in Bewley 1984:32) describes the climatic change, (i.e. from cold and dry to warm and humid), as happening "[a]*t the **end** of* [Layer] *2a*" (Leroi-Gourhan in Bewley 1984:30; emphasis mine). What is only implied but never clarified or elaborated upon by the author of the pollen study, are the contextual implications of this change from cold to warm climate in relation to the lithic assemblage from Layer 2a.

Bewley (1984:34), commenting on the brief sedimentological study on particle size analysis of the sediments by Green (in Bewley 1984:32-34), does, however, suggest that "*the pollen evidence suggests that in layer 2 the climate ameliorated even to the degree of being called an interstadial*". He goes on to tentatively correlate the high percentage of 80% (maximum concentration) arboreal pollen in Layer 2 with its correspondingly low sand frequency of <16%.

Layer 2, *not* Layer 2a, clearly is where the Interstadial signal appears (Figure 2 in Leroi-Gourhan 1981:77; Figure 20 in Leroi-Gourhan in Bewley 1984:31). The 80% arboreal pollen signal in Layer 2, its peak, is recorded at 140 cm below datum, while the end of Layer 2a at ca. 178 cm below datum is recorded as having just around 10%.

The main period of site-use, and thereby the main concentration of depositions of lithics at Houmian, of Layer 2a, (see Chapter 5) therefore cannot, as maintained by Lindly (1997:18, 26), have been during an Interstadial; rather, it must have occurred, together with the lithics accumulation, *before* said Interstadial.

In his review of the palynological studies, Lindly (1997:38) erroneously maintains that "[a]*t the end of* [Layer] *2a there is a marked increase of arboreal pollen to nearly 80% of the sample*." This misrepresentation is reiterated a second time in his summary of faunal remains: "*Level 2a, with an 80% arboreal pollen result, could have been deposited during stage 5e*" (Lindly 1997:46). Lindly (1997:50) repeats this demonstrably false claim in his chapter on chronology: "*at the end of Layer 2a, arboreal pollen increases to 80% and the conditions appear to be both warmer and wetter*".

That Lindly's claim is demonstrably *not true* is clear from the pollen diagrams in the figures of both Leroi-Gourhan's (1981) and Bewley's (1984) articles mentioned above.

It is then surprising that Lindly (1997:46), at the end of his chapter on "The Environment, Climate and Geology", claims that "[t]*he cave* [sic] *was not occupied after this period of the Middle Paleolithic, perhaps due to fluctuating climatic conditions in stage 5d to 5a and the cold conditions of stage 4*". Not only does this argument make little sense, but also, if it were true that hominins would not utilise the favourable climatic conditions of a peak interstadial (Layer 2), but would rather use the Houmian rockshelter during a less favourable, milder climatic period (Layer 2a), this effectively undermines Lindly's own argument expressed in the Summer Adaptation Hypothesis.

Lindly even seems to acknowledge this when he states:
"*As Houmian is situated at 2000 m above sea level, the climatic amelioration seen in Layer 2 must have been enough to increase the tree line to nearly modern levels. In fact, the majority of lithic artifacts and faunal remains recovered from this site are from Layer 2a, suggesting a greater use of the cave during this period*." (Lindly 1997:38).

Accordingly, based on the above discussion of the available data for suggesting a dating of the Houmian lithic assemblage used in this thesis, a date around MIS 5d and MIS 5c is proposed. The material from Houmian used in this thesis comes from Layer 2a, which is ca 20-50 cm in thickness (Bewley 1984:16) (Figure 33 - Figure 35).

2.8.5.4 Ksar Akil

Based on techno-typological studies (Marks and Volkman 1986), the assemblages used in this thesis, XXVIIIA(28A), XXVIIA(27A), and XXVIA(26A) have been relative-dated through their correlation with the Levantine Mousterian 'Tabun D' for the older Level XXVIIIA(28A), and Levantine Mousterian 'Tabun C' for the younger levels XXVIIA(27A) and XXVIA(26A). Shea (2013:106) prefers the more contextual labels "Early Levantine Mousterian" and "Interglacial Levantine Mousterian", which would see the former being dated to before 130,000 BP, i.e. before the Last Interglacial, and the two latter being dated to the Interglacial period of 130,000-75,000 BP. This does not seem to fit with the radiometric dates. Clearly there is a vast discrepancy between the radiometric dates and the extrapolated dates. Considering both the depth of the Mousterian deposit at Ksar Akil, and taking into account the radiometric dates as well as the extrapolated dates, this study will start from the assumption that the Mousterian layers could be suggested to range from ca. 71,000-50,000 BP, for the younger layers XXVIB(26B) and XXVIA(26A); meanwhile, the older layers XXVIIIB(28B) and XXVIIIA(28A) could possibly be associated with Interglacial times (i.e. MIS 5), ca. 130,000-71,000 BP.

2.8.6 Summary of chronology

New dates for the beginning of the Upper Palaeolithic in the Zagros have afforded a mutual *terminus ante quem* for the end of the Mousterian for sites with Middle Palaeolithic deposits.

Shanidar now has new dates from its Upper- and from the top half of its Middle Palaeolithic layer. A date of ca. 42,000–35,000 cal. BP for the Baradostian, and two dates from the Mousterian at 55,000-45,000 BP and 70,000-60,000 BP. A conservative correlation would date sub-layers D4a, D4b, and D4c at 70,000-60,000 BP., and a more liberal extrapolation would suggest ca. 90,000-70,000 BP. A conservative date would situate the assemblage in MIS 4, and a liberal date at the end of MIS 5.

For Warwasi, given that there is no hiatus between Middle- and Upper Palaeolithic levels, a tentative date of 45,000-40,250 cal BP for the end of the former can be extrapolated. A further extrapolated date (for the purposes of this study) of 55,000-45,000 BP can tentatively be proposed for spits ‘WW’ and ‘XX’. Such extrapolated date would place the assemblages in MIS 3.

Layer 2a at Houmian has an old radiometric date of 148,000 ± 35,000 BP, and has been proposed a “Brørup” date through a palynological study, equivalent to MIS 5c (105,000-95,000 BP) (peak ca. 96,000 BP). Situating Layer 2a somewhere in the middle of MIS 5 seems appropriate.

Ksar Akil has new radiometric dates for its oldest Upper Palaeolithic layer, XXV(25), at 45,900 cal BP. The second youngest Mousterian layer XXVIB(26B) is dated to ca. 47,000 BP. Generally accepted extrapolated dates of around 50,000 BP for the oldest Mousterian layers, XXXVI(36), are regarded (by this author) to be too conservative. However, assigning MIS 6 or MIS 5 dates to the mid- to upper part of the Mousterian stratigraphy must likewise be considered tentative. Somewhere in the middle seems more acceptable. Thus, the material from Ksar Akil used in this study is presumed to range between ca. 130,000-71,000 BP for Level XXVIIIA(28), and ca. 71,000-50,000 BP for Layer XXVIA(26A).

2.9 Summary

Chapter Two provided a perspective on southwest Asia as a main region for research on human behavioural evolution. Southwest Asia is an important study area given its history of Neanderthal and modern human interaction, and its corpus of especially lithic data has shown it to provide evidence of both behavioural complexity and regional lithic variability from around MIS 7-8. Three main areas, or spheres, of behaviourally significant data seen to increase in variability of expression around this period were presented. The first was evidence for symbolic behaviour in the Middle Palaeolithic. The second was degree of faunal exploitation, where the published faunal assemblages, from Zagros sites analysed in this thesis, as well as related behavioural implications, were presented. The third was lithic technological variability, which was discussed in depth.

An evolutionally important observation on the latter has been that both Neanderthals and modern humans, in southwest Asia, have been associated with Middle Palaeolithic "Mousterian" toolkits. It has, however, proven difficult to demonstrate whether a specific lithic assemblage was produced by Neanderthals or modern humans. For that reason, this thesis will not engage with this issue, but strictly focus on the lithic variability found among the presented sample sites. This is argued to be justified based on the framework of the "Summer Adaptation Hypothesis", presented in Chapter 1, which sees the Zagros Mousterian being defined exclusively by techno-typological conditions.

Middle Palaeolithic lithic assemblages (especially those from older excavations) are rarely associated with other sources of information, such as environmental, stratigraphic, or chronometric proxy data. Given this, heuristic devices can be used to assist in interpretation. An introduction to various concepts used in Middle Palaeolithic research was given. These included ways of quantifying, interpreting, and explaining tool use, including behaviour around production, use, and discard.

The limited amount of available chronometric data, both radiometric dates and environmental proxies, were presented and discussed. From this, the issues of chronological contemporaneity of sites within the Zagros, as well as their associated lithic assemblages, were examined and discussed. This was done in order to appreciate the extent to which the sites selected for study in this thesis could reasonably be argued to be comparable.

In order to better understand the study area of the Zagros Mountains, an introduction to other areas of southwest Asia was given. It was discussed how research history had favoured the Levant in the 20th Century, and through this effort had established chronological and techno-typological schemes which ended up being utilised as, essentially, universal yardsticks throughout southwest Asia.

Chapter 3 - Climate, Environment, Physiography, and Site Selection

3.1 Introduction

The following will be an overview of major forces of the natural world, their inter-relations and how they each, and in combination, creates climates and shape environments. The purpose of this chapter is to introduce some of the climatological, environmental, and physiographic parameters governing landscapes, first on a broad scale (world), and afterwards on a regional scale (the Zagros Mountains). Starting in deep geological time before moving to the Pleistocene and modern day, it is the intention to demonstrate the continual, ongoing change to landscapes as well as the immense potential for climatic variability, even within relatively confined areas. In order to attempt to reconstruct palaeoenvironments that Pleistocene hominins inhabited, it is necessary firstly to appreciate the scale and complexity of the natural forces that governs climate. This is attempted to explore the possibility for presenting an argument against the notion held by some researchers (e.g. Lindly 1997, 2005; Roustaei et al. 2004:695), that the Zagros Mountains were uninhabitable during autumn, winter, and spring, continually, throughout the Pleistocene. It is, in particular, the purpose of this chapter to demonstrate, if not in practice, then in theory, the complexity to palaeoclimatic and palaeoenvironmental reconstruction in the Zagros Mountains.

The last part of this chapter is dedicated to an introduction to physiographic features in montane environments, and a presentation of a model of reconstruction of Palaeolithic landscapes in the Zagros Mountains (Heydari-Guran 2014). This model will act as a backdrop to my site selection.

3.2 Worldwide climate change, Icehouse Earth, and the birth of the Pleistocene

Throughout most of the current Cenozoic Era, the earth has been experiencing a general cooling trend known as icehouse Earth. This cooling trend started after the Early Eocene Climatic Optimum (EECO) about 49 Ma (Speelman et al. 2009), and implies that at least one permanent ice sheet is present on the globe, in this case the Antarctic ice sheet, which started forming ca. 45.5 Ma (Ehrmanna and Mackensen 1992). The reason for this general shift into perpetually colder climates is proposed to be caused by a multitude of particular, but interrelated, natural phenomena occurring in the five main systems operating within the planet. These are the *geosphere* (e.g. tectonic plates, mountains), *hydrosphere* (liquid water), *cryosphere* (frozen water), *atmosphere* (layer of gasses surrounding the earth), and *biosphere* (living organisms/ecosystems within any sphere) (Condie 2015).

3.2.1 Geosphere

In the geosphere, the trend towards a colder climate, amongst other factors, involved changes to, and distribution of, land masses (i.e. continents relative to oceans), which could lead to opening and closing of oceanic gateways, and the movement on land of tectonic plates and orogeny, with formation of mountains impacting wind regimes (Kocsis et al. 2014).

3.2.2 Hydrosphere

In the **hydrosphere**, variations of water bodies – especially the changes to distributions of oceans as continents gradually broke up and shifted position – meant changes to ocean heat transport. This especially impacted Antarctica, as the initial opening of Drake Passage and the Tasmanian Seaway (Southern Ocean gateways) at ca. 37 Ma and 33.5 Ma, respectively, is believed to have been partly responsible for the commencement of its, still active, glaciation, by cutting it off from sufficient poleward heat convergence, establishing the

Antarctic Circumpolar Current, effectively creating the thermal isolation of the Antarctic continent (Diester-Haass and Zahn 1996; DeConto and Pollard 2003).

3.2.3 Cryosphere

The **cryosphere**, including the polar ice cap(s) and other land-based glaciers, would act to lock enormous amounts of water, restricting them from active circulation. Such ice sheets are inducive to increasing the albedo value for that particular part of the earth's surface, thereby making that surface reflect more sunlight back into space. This relative loss of solar energy leads to the cooling of that area, and can be conducive to a positive feed-back loop driving the temperature down even further (Condie 2015).

3.2.4 Atmosphere

Global temperature is further influenced by the **Atmosphere**, specifically how much CO_2 is accumulated there at any one time. High and low levels of CO_2 contribute to processes warming and cooling the earth, respectively. As such, the climatic state of the planet is said to be an interplay between geological sources and sinks (reservoirs) of carbon related to the ocean-atmosphere system (Macdonald et al. 2019:181). It has been proposed that a post-EECO slow-down of tectonic-induced CO_2 emissions by drivers such as volcanic activity or orogeny, which can produce what is referred to as metamorphic release of atmospheric CO_2 through chemical weathering (Bohaty and Zachos 2003), critically contributed to the complex litany of environmental factors sustaining the onset of the current icehouse Earth. The presumed scenario is that as the atmospheric CO_2 concentration steadily declined, temperature and precipitation decreased, thereby slowing chemical weathering of carbonate and silicate rocks, further reducing the release of CO_2 (Kump, Brantley and Arthur 2000; Zachos, Dickens and Zeebe 2008).

3.2.5 Biosphere

An important factor occurring in the **biosphere**, were the so-called Azolla-event ca. 49 Ma (Speelman et al. 2009). A free-floating freshwater fern, the Azolla is believed to have initially spread explosively (i.e. bloom) around the Arctic during the extremely warm conditions of the Early Eocene EECO (Barke et al. 2012) and through photosynthesis drawn CO_2 out of the atmosphere. Due to a relatively rapid and catastrophic decline/collapse of this zone of Azolla, resulting in its sinking to the bottom of the sea, a so-called sequestration (trapping) of its accumulated CO_2 was permanently locked in the seabed. This resulted in what is known as a draw-down event, where CO_2 in the atmosphere is declining (Pearson and Palmer 2000).

3.3 Orbital forcing, acceleration of ice ages, and Pleistocene climate change in the Zagros

Throughout the Quaternary, the earth experienced long-term cooling and warming events, precipitated by complex interactions of orbital forcing, resulting in oscillating expansions and contractions of continental ice sheets (e.g. Martin-Garcia 2019). This is what we know as glacial/interglacial periods. Specifically, the beginning and end of glacial periods, is understood to be caused by seasonal flux of solar energy being received by the Earth's surface (Carré and Cheddadi 2017:173).

3.3.1 Orbital forcing

There is general agreement among scientists that three main planetary factors affect the Earth's climate (e.g. Hays et al. 1976; Shackleton et al. 2003; Bradley 2015, pp. 36-50). These are all related to Earth's orbit around the Sun and are collectively known as *orbital forcing*, where forcing implies the changes in natural conditions on Earth caused by variations in the amounts of sunlight (solar radiation) reaching specific surfaces of the planet at a given time, depending on the trifactoral variations of *orbit*, *tilt*, and *precession* of planet Earth. Each of these factors have individual millennial-scale cycles and are more broadly known within the context of Palaeolithic archaeology as *Milanković cycles*, named after the Serbian geophysicist and astronomer Milutin Milanković who first propounded these theories in the first half of the 20th Century. In short, the study of these dynamics demonstrates the consistent and cyclical undulation of Earth's climate and resulting environmental changes throughout geological time.

3.3.1.1 Orbit

The first of these three factors are the *orbital eccentricity* of the Earth. As the planet travels around the Sun it oscillates from a fairly circular to an explicitly elliptical orbit. The more elliptical the orbit, the greater the difference between the amounts of solar radiation (sunlight) the Earth receives at either extreme, i.e. when closest to the Sun (called perihelion), and furthest away (called aphelion). Simply put, this alternately influences the intensity of summer and winter on the Earth's hemispheres. More specifically, while not yet fully understood by scientists, eccentricity is recognised as playing a role in the onsets of glacials and interglacials, with the former propelled, in part, by a more elliptical orbit, and the latter stimulated through a circular one. A full cycle takes about 100 kyr to complete (Bradley 2015: 41).

3.3.1.2 Axial tilt

The second factor is the *angle of tilt* of the Earth's axis relative to its plane of orbit around the Sun (ecliptic), known as *obliquity*. Within a ca. 41 kyr cycle, as the axis of the Earth tilts slowly between 21.8° and 24.4° the amount of solar radiation, or insolation, upon the higher latitudes of each hemisphere fluctuates. Broadly speaking, this causes a difference in intensity between summer and winter temperatures. At low latitudes, i.e. closer to the equator, there will be little difference in the amount of solar radiation receipts at any given time. At higher latitudes, however, an increased angle of tilt will have a considerable influence on solar radiation receipts, which will vary greatly (Bradley 2015: 36-46).

3.3.1.3 Precession

The third factor is the *direction of tilt* of Earth's axis – called *precession*. Because of the gravitational forces of the Sun, the Moon, and other planets in the solar system, specifically Jupiter and Saturn, the direction of tilt of the Earth's axis, like its angle, and again relative to the ecliptic, is not constant but revolves in a circular motion (precession). This circular motion changes the way the Earth's axis orientates and aligns itself towards different celestial bodies, for example the ecliptic coordinate system of the zodiac. This slowly changes the timing of the seasons on Earth, i.e. the solstices and equinoxes, making them shift systematically across the calendar year in the space of one full cycle. One full circle takes ca. 21.7 kyr. This is known as the precession of the equinoxes. This phenomenon is a critical variable as it shifts the timing of perihelion and aphelion in relation to eccentricity and obliquity, each of which will result in distinct interrelated influences and effects (Bradley 2015: 36-46).

3.3.2 Acceleration of ice ages

Around 900-650 ka, sometime within the Early Middle Pleistocene Transition, a pronounced intensification began of cycles of glacial/interglacial climates (Maslin and Brierley 2015: 47). It is proposed that glacial/interglacial cycles previously were caused by the obliquity orbital periodicity of ca. 41ka, but this seems to have changed around MIS 22 to cycles of ca. 100 ka (Maslin and Brierley 2015). Cycles now began to demonstrate extended durations coupled with distinct increase in amplitude in global ice volume variations (Maslin and Brierley 2015; Elderfield et al., 2012) (Figure 2).

Climatic proxies, such as foraminiferal oxygen isotopes have in recent decades been instrumental in providing detailed information on glacial/interglacial cycles, and stadial/interstadial stages. An example is the "LR04" benthic stack of average $\delta^{18}O$ signals of each marine isotope stage and substage within the Pliocene and Pleistocene created by Lisiecki and Raymo (2005) (Figure 3). While the resolution of such proxies is not always specific enough to be globally applicable, they are currently some of the best resources we have for correlating climate and environment in regions poor in published local proxies, like the Zagros.

Smaller oscillations in these δ18O values, known as Dansgaard-Oeschger events (Johnsen et al. 1992; Dansgaard et al. 1993), reveal millennial-scale changes to climate. For stadials, this is expressed through slow cooling phases at its onset, and for interstadials it is articulated, at their onset, through fast temperature rises (Kehl 2009: 1-2).

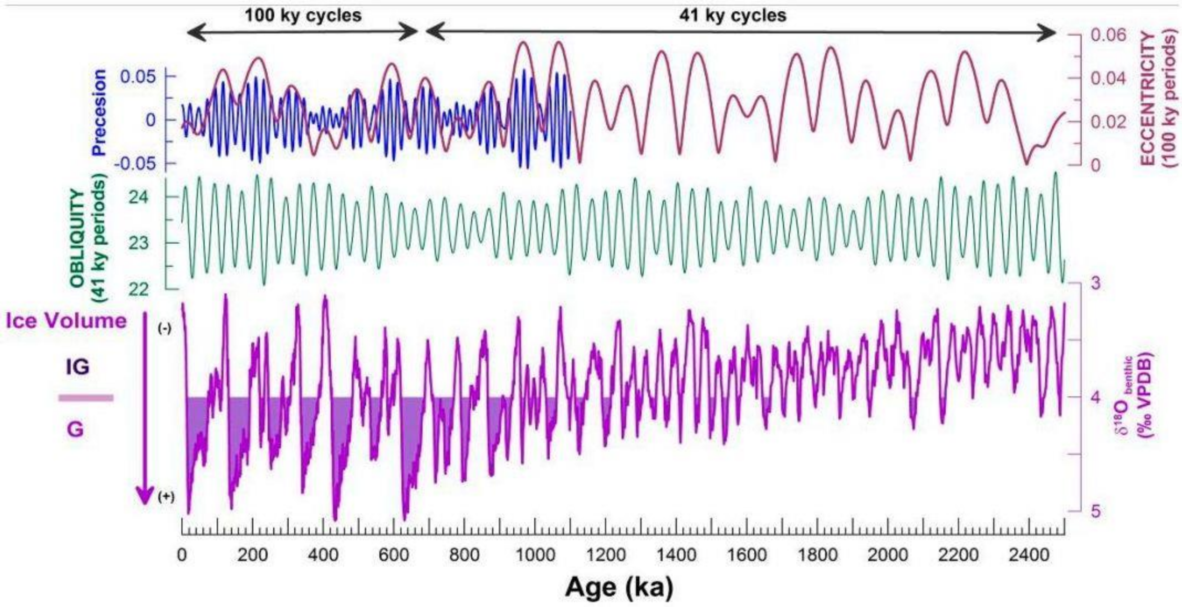

Figure 2 - Climate cycles during the Quaternary and their correspondence with orbital parameters. From bottom to top: The ice volume is indicated by the benthic δ18O; purple fill shows the ice volume threshold separating glacial (G) and interglacial (IG) condition (taken from Martin-Garcia 2019:2, Figure 1)

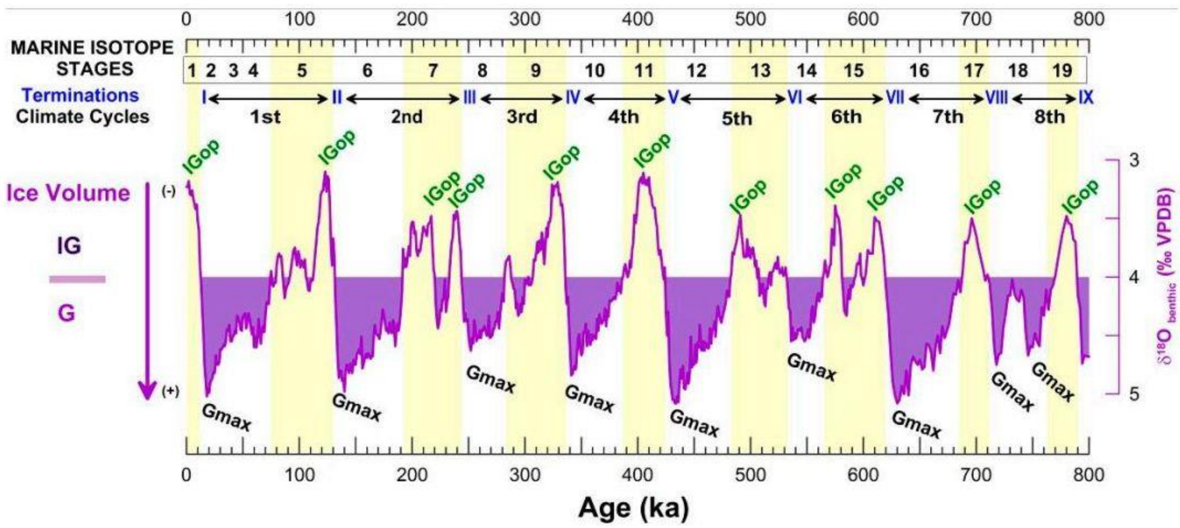

Figure 3 - Glacial cycles for the last 800,000 years. The ice volume is indicated by the benthic $\delta^{18}O$; purple fill shows the ice volume threshold separating glacial (G) and interglacial (IG) conditions. Marine isotope stages, terminations (in roman numerals), and climate cycles are represented on top. Yellow bands highlight interglacial stages, which are defined by convention. Iop, interglacial optimum; Gmax, glacial maximum (taken from Martin-Garcia 2019:2, Figure 2)

3.3.3 Pleistocene climate change in the Zagros

Compared to other regions, such as the Levant (e.g. Enzel and Bar-Yosef 2017; Langgut et al. 2011), Pleistocene climate change in Iran is not well known (Kehl 2009: 2). The climate in Iran during the Pliocene to Lower Pleistocene is thought to be somewhat more humid than today, based on observations of brown silt and clay layers in the lower layers of the Qom Playa, associated with a quasi-permanent lake environment (Kehl 2009: 5; Bobek 1963).

3.3.3.1 Loess-soil sequences from loess deposits

The Middle Pleistocene has recorded climatic changes within loess deposits in northern Iran (Kehl et al. 2005; Frechen et al. 2009). Kehl (2009: 5) states that:

"[i]*n general, the accumulation of loess involves a series of climate-controlled processes including the production of mainly silt-sized particles, their deflation, eolian transport and deposition as well as syn- and post-depositional transformations including soil formation. Unweathered loess can be correlated with stadial phases, reflecting dry (and cold) conditions during dust accumulation under* *a sparse vegetation cover, whereas palaeosoil horizons indicate comparatively moister (and warmer) conditions and steppe or forest vegetation during interstadials and interglacials*".

Work in the Alborz Mountains has provided specific evidence of interstadials in Iran within the MIS 6 glacial, based on the development of palaeosols intercalated with loess deposits (Kehl et al. 2005; Frechen et al. 2009). Palaeosols correlated to MIS 7, 9, and 11 (or older) interglacials have also been identified (Kehl 2009: 6).

3.3.3.2 Pollen records from lake sediments

Environmental reconstruction of the late Middle to Late Pleistocene has been proposed based on pollen samples obtained from a sediment core from Lake Urmia, north-western Iran, from which Djamali et al. (2008) defined a local scheme of glacial/interglacial periods.

3.3.3.3 MIS 7 (Aveley Interglacial) (ca. 243-191 ka) and "Laylan" Interstadial (MIS 7a, ca. 190 ka)

The MIS 7a Laylan Interstadial, occurring at the end of the MIS 7 Aveley Interglacial, saw a modest expansion of steppe forest, including oak, juniper, and Pistacia, in the Zagros Mountains (Djamali et al. 2008: 418).

3.3.3.4 MIS 6 or "Bonab" Glacial (ca. 191-135 ka)

This steppe forest gave way in the MIS 6 Bonab Glacial to a steppe of shrubs the likes of mugwort, wormwood, and sagebrush (*Artemisia*), and various grasses. A substantial signal of desert shrubs (*Nitraria*, *Pteropyrum*, and *Atraphaxis*) is proposed to imply semi-desertic conditions more severe in general than that of the Last Glaciation (Djamali et al. 2008).

3.3.3.5 "Ashk" Interstadial (ca. 135-130 ka)

At the end of MIS 6, and interstadial called the Askh Interstadial is recognised through an expansion of a joint-pine (*Ephedra*) shrub-steppe, followed just before the start of MIS 5e by an *Artemisia* steppe, signifying severe aridity (Djamali et al. 2008).

3.3.3.6 MIS 5 or "Sahand" Interglacial (Eemian) (ca. 130-71 ka)

The Last Interglacial, MIS 5e-a, is named the Sahand Interglacial in the local system of Djamali and colleagues. A parallel of dynamics of forest tree expansion in the MIS 6-MIS 5 transition as compared to the late glacial-Holocene, show that Caucasian elm (*Zelkova Carpinifolia*) was more prolific in MIS 5. Djamali and colleagues suggest that: "*the climatic conditions of the LI* [Last Interglacial] *must have been optimal for this species, compared to the Holocene. This mesic, thermophilous, Euxino–Hyrcanian relict element … **indicates milder winters** and periods of more spring or summer rainfall*" (Djamali et al. 2008: 418, emphasis mine).

3.3.3.7 MIS 5 stadials/interstadials

This local system identifies two interstadials and two stadials within the Sahand Interglacial. These are the "Kaboudan" interstadial I and II, and the "Espir" Stadial I and II, respectively. These four stadials and interstadials are very closely correlated to MIS 5d-a (Figure 4).

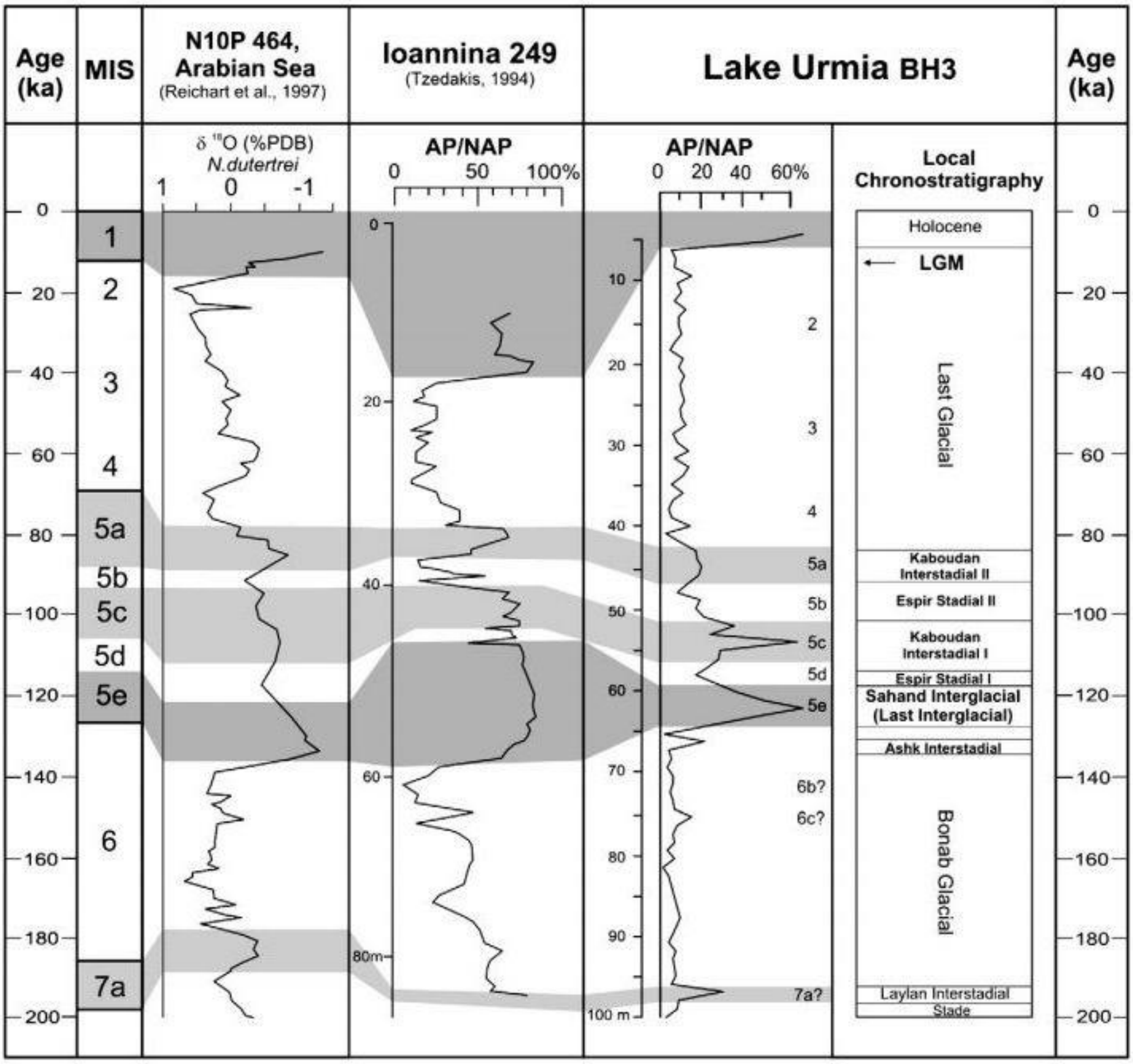

Figure 4 - The Lake Urmia sediment core (BH3) with introduction of local chronostratigraphic terminology. Its curve of arboreal (AP)/Non-arboreal (NAP) pollen diagram is correlated with the Indian Ocean isotopic records and a long pollen record from northwest Gree Greece (From Djamali et al. 2008:417, figure 3).

In sum, while multiple climatic changes transpired in and around the Zagros Mountains during the Pleistocene, it is the direction and timing of these changes that still are in need of being better understood. What can be cautiously appreciated is that interglacial periods were very similar climatically to the present day, with glacial periods being drier and colder (Kehl 2009:13).

3.4 Modern climate in and around the Zagros Mountains

Modern climate in Iran is affected by pressure systems such as the Siberian High, the Westerly depressions and the SW Monsoon, making it mostly Mediterranean (Kehl 2009:1). The Zagros Mountains are located within what is known as the Iranian highlands (Figure 5). Together with the Alborz Mountains, located to the east and northeast of the Zagros, and bordering the southern coast of the Caspian Sea, they are considered Alpine, denoting they reach altitudes above the tree line. While today, a large part of Iran (ca. 75%) has semi-arid or arid climate, with annual precipitation rates ranging between ca. 350-50 mm, the north-western parts of the Zagros, the Alborz, and the Caspian lowlands receive annual precipitation rates of 1000 mm or more (Kehl 2009: 2; Ehlers 1980). Oroomieh, in the Zagros, at 1316 m.a.sl., has a mean annual precipitation of 341 mm, a mean annual temperature of 11.5°, with a monthly mean daily temperature difference at 25.7°. Shahrekord, at 2049 m.a.s.l. higher up in the Zagros Mountains, has a mean annual precipitation of 317.7 mm, but very similar figures for mean annual- and monthly mean daily temperature. Yazd, on the other hand, at 1237 m.a.s.l. on the eastern side of the Zagros, only experiences a mean annual rainfall of 15-20% of the former two areas recorded at 60.8 mm. Although it has a similar monthly mean daily temperature difference, its mean annual temperature is almost twice as high. Dezful, located close to the western foothills of the Zagros at 143 m.a.s.l., exhibits a parallel monthly mean daily temperature difference to the other locations mentioned, but enjoys 404.6 mm of mean annual rainfall and a mean annual temperature of 24° (Table 1). The reason for this is that the Zagros and the Alborz act to effectively shield the rest of the country, collectively referred to as the Iranian Plateau, from wind systems such as north-westerly and westerly depressions coming in from the Caspian and the Mediterranean seas (Kehl 2009). Figures for mean annual rainfall and temperatures are given in table 1. While modern climatological data lacks resolution, especially in the high mountains, it is understood that both for rainfall and for temperature, regional gradients can fluctuate, being more or less prominent in e.g. river valleys (Kehl 2009). During summer, a strong 'heat low' is prevalent over south-central Iran (Ganji 1968; Saligheh 2003; Kehl 2009). A heat low, or 'thermal low', is low barometric (atmospheric) pressure in a region owing to intense local heating of the earth's surface (Holton and Hakim 2013:339). This summer heat low in Iran is associated with a relative pressure high reigning over Eurasia (Kehl 2009). In winter, the prevailing wind systems consists of air pressure gradients between the Siberian anticyclone and the equatorial low-pressure system (Ganji 1968; Kehl 2009). Glaciers still exist in the highest peaks of the Alborz and Zagros mountains, such as Kuh-e Damavand (5,671 m.a.s.l), Alam Kuh (4,850 m.a.s.l) and Kuh-e Savalan (4,811 m.a.s.l) in the former, and Zardeh Kuh (4,548 m.a.s.l) in the latter, with a total extent estimated at ca. 20 km^2 (Bobek 1968; Ferrington 1988). Additionally, Shir Kuh (4,060 m.a.s.l), east across the Zagros from Zardeh Kuh, retains small permanent snow patches located on its north-eastern slopes (Kehl 2009).

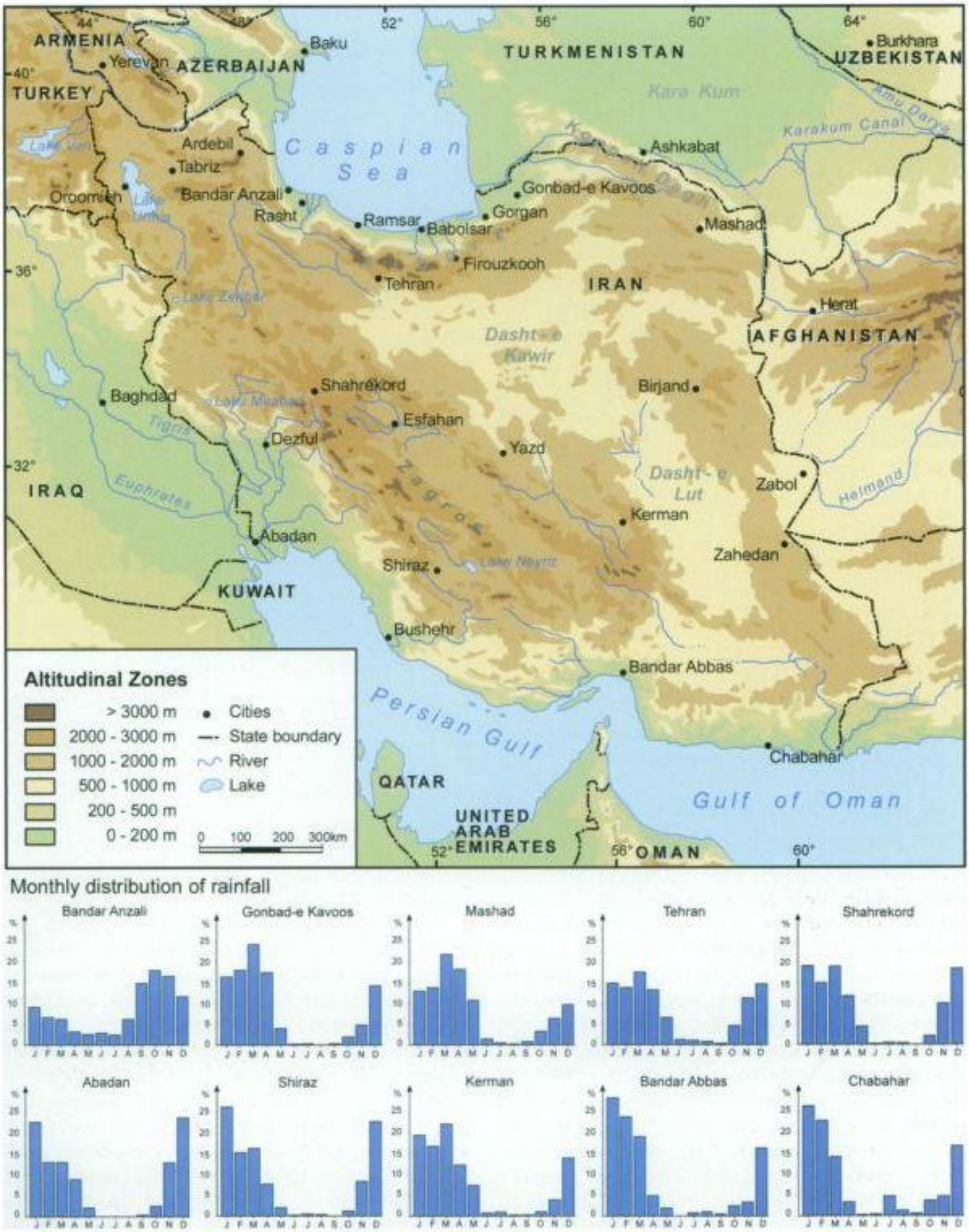

Figure 5 - Physiographic map of Iran and modern monthly precipitation for selected meteorological stations (From Kehl 2009:3, figure 1).

Table 1: Precipitation and temperature data of selected meteorological stations in Iran (for locations see Fig. 1)

Station	Altitude (m a.s.l)	Mean annual precipitation (mm)	Monthly mean daily temperature (°C) Min.	Max.	Difference	Mean annual temperature (°C)	Period
South-Caspian lowlands							
Bandar Anzali	-26.2	1853.5	7.1[1)]	25.9	18.8	16.2	1951–2005
Ramsar	-20.0	1217.8	7.3[1)]	25.3[2)]	18.0	16.0	1955–2005
Babolsar	-21.0	894.4	7.8[1)]	26.5[2)]	18.7	17.0	1951–2005
Gorgan	13.3	601.0	7.9	27.8[2)]	19.9	17.8	1953–2005
Gonbad	37.2	435.8	7.8	29.9[2)]	22.1	18.5	1995–2003
Iranian highlands							
Oroomieh	1316	341.0	-1.8	23.9	25.7	11.5	1951–2005
Tabriz	1361	288.9	-1.7	26.0	27.7	12.5	1951–2005
Ardebil	1332	303.9	-2.5	18.3	20.8	9.0	1977–2005
Tehran	1191	230.5	3.7	30.2	26.5	17.2	1951–2003
Firouzkooh	1976	282.8	-3.9	20.5	24.4	8.8	1994–2003
Mashad	999	255.2	1.7	26.5	24.8	14.1	1951–2005
Shahrekord	2049	317.7	-1.5	24.0	25.5	11.8	1955–2003
Esfahan	1550	122.8	3.4	28.9	25.5	16.2	1951–2005
Shiraz	1484	346.0	6.2	29.2	23.0	17.7	1951–2005
Yazd	1237	60.8	5.9	31.9	26.0	19.1	1952–2005
Birjand	1491	170.8	4.4	27.7	23.3	16.5	1955–2005
Kerman	1753	152.9	4.6	26.7	22.1	15.8	1952–2005
Zabol	489	61.0	8.6	34.6	26.0	22.1	1963–2005
Zahedan	1370	90.6	7.3	28.5	21.2	18.4	1951–2005
Khuzestan plain and Persian Gulf area							
Dezful	143	404.6	11.5	36.3	24.8	24.0	1961–2005
Abadan	6.6	156.0	12.7	36.6	23.9	25.4	1951–2005
Bushehr	19.6	279.1	14.4	33.2[2)]	18.8	24.6	1951–2005
Bandar Abbas	10.0	185.5	17.8	34.3	16.5	27.0	1957–2003
Chabahar	8.0	113.9	19.9	31.4[3)]	11.5	26.2	1963–2003

1) coldest month in February, other stations in January
2) hottest month in August, other stations in July
3) hottest month in June
Data source: IRAN METEOROLOGICAL ORGANIZATION (2008)

Table 1 - Figures for modern mean annual rainfall and temperatures in Iran (From Kehl 2009:4, table 1).

3.5 Altitudinal zonation, microclimates, and microhabitats

Palaeoclimatic and palaeoenvironmental correlation of archaeological site stratigraphy with regional proxies is rarely straightforward (e.g. Bewley 1984; Lindly 1997; Solecki 1963). Less so in topographically complex areas such as the Zagros Mountains (Haslett 1997). Mountainous regions, the scale of which the Zagros fall under, are governed by what is known as *altitudinal zonation*, making the Zagros prone to comprise areas and locales featuring *microclimates*. Microclimates can create conditions for *microhabitats*, a habitat being the natural environment wherein a species live. Below, I will briefly describe those concepts, as a further appreciation of the interaction of climate and environment on physiography.

3.5.1 Altitude and elevation

Altitude and elevation should not be confused, as, technically, they refer to two separate measurements. The former denotes the distance between an object and e.g. mean sea level or land surface, where "*the object is not in direct contact with the reference point/stratum*", and the latter refers to the distance between an object and e.g. mean sea level, where object and reference point is in physical contact (McVicar and Körner 2013:335). However, so as to not inadvertently exclude other relevant studies pertaining to Palaeolithic research, in which either altitude or elevation is used to refer to the same thing (likely object and reference point in physical relation), I will use the two terms interchangeably in this text.

3.5.2 Altitudinal zonation, aspect, and slope effect

Altitudinal zonation is defined as changes to various environmental and climatic factors depending on increased or decreased elevation (Figure 6). These changes can be to factors such as atmospheric pressure, insolation, temperature, rainfall, relative humidity, wind velocity, evaporation, soils, and topography (i.e. abiotic factors) (Daubenmire 1943:343-357; Barry 2008:11-14: Jones 2014:297-301). Within the altitudinal zonation, features such as *aspect* and *slope effect* further contribute to the complex set of influences dictating the creation of ecosystems and habitats. Aspect designates the exposure or direction in which a slope face (e.g. Mahmoudi, Khoramivafa and Hadidi 2018). Shanidar Cave, for instance, has its opening, or mouth, facing south, i.e. a southern exposure. In a northern hemispherical situation, a southern aspect will receive more solar irradiance (amount of solar radiation obtained per unit area by a given surface) than a northern aspect, which will result in a warmer and drier climate as opposed to a northern aspect (e.g. Elliott and Kipfmueller 2010:53), as well as a difference in soil moisture, i.e. less in a former and more in a latter (Påhlsson 1974). The angle of a slope moreover impacts the influence of the aspect and together those interacting parameters creates a multitude of possible conditions, known as *slope effect*, for different microclimates (e.g. Barry 2008:87-97). The environmental and climatic variation this creates necessarily impacts both flora and fauna (i.e. biotic factors).

Altitudinal zonation, aspect, and slope effect are thus defined by different microclimates (Figure 6).

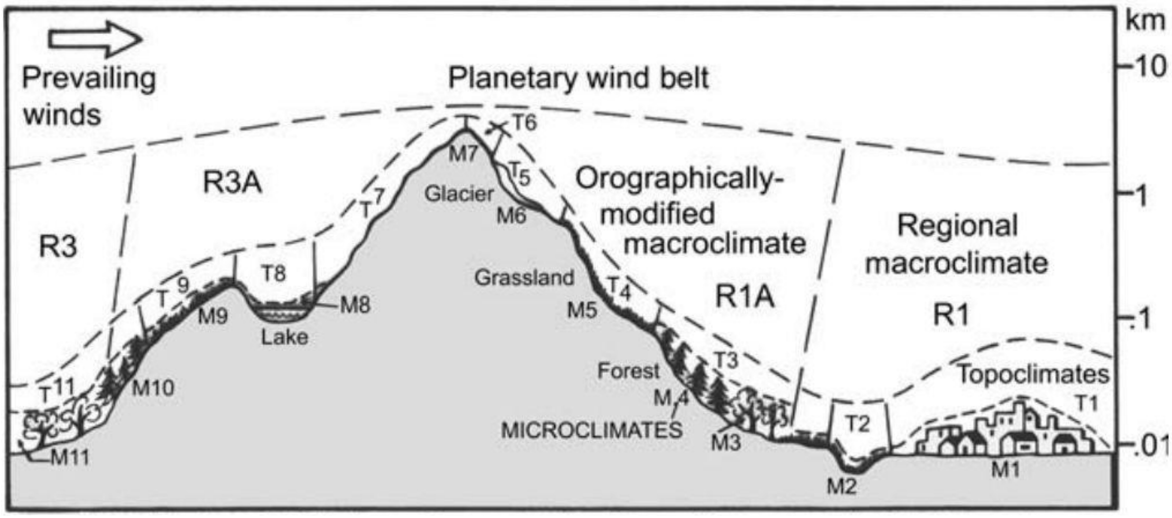

Figure 6 - Scales of climatic zonation in mountainous terrain. R, regional macroclimate; T, topoclimate; M, microclimate (From Barry 2008:13, figure 1.5).

3.5.3 Microclimates

The concept of *microclimates* was born out of climatological research into the interdependence of temperature, air moisture, soil, and vegetation on each other near the surface of the earth (Geiger 1965). This branch of science has illustrated how a relative surface area can contain more than one climate at any one time. As such it is commonly accepted that climatic conditions can serve to produce and sustain various "smaller" climatic situations within the boundaries of a relative area, i.e. microclimates (Geiger, Aron and Todhunter 1995; Keppel et al. 2017). What this means for archaeological site reconstruction, and especially its implications for interpretations of hominin site use, is that generalisations over large areas or regions can not necessarily be assumed to be correct. The influence of topography and terrain on microclimate, as briefly mentioned above, further needs to be appreciated (Geiger, Aron and Todhunter 1995: 327-406). Microclimates create the possibility of the existence of microhabitats (Fridley 2009; Dobrowski 2011; Ashcroft and Gollan 2013).

3.5.4 Microhabitats

While microclimate refers to climatic variables, a microhabitat is usually site specific, and usually refers to one or more species mutually dependent on those particular sets of microclimatic factors. A microhabitat specifically has the ability to act as a buffer to the severe effects of weather events, i.e. to significantly lessen the impact of the climatically induced environment. This can function to shield parts of the intrinsic biodiversity within the affected area (Keppel et al. 2017:1; Fridley 2009).

3.6 Heydari-Guran's model of Palaeolithic landscapes

3.6.1 Introduction

Heydari-Guran (2014), in his seminal study, constructed a framework for considering Palaeolithic settlement system boundaries in Iran. Conceptualised as a hierarchical structure, he argues that the way to approach this is to understand which factors control the ecosystem size at which scales. Heydari-Guran defines Palaeolithic space in terms of the four environmental factors of geology, structural landscapes, hydrology, and climate (Heydari-Guran 2014: 30-31). This leads him to articulate a seven-tiered framework of Palaeolithic geographical space ranging from largescale to smallscale, delineated as "**macrozone**", "**ecozone**", "**home-range zone**" (including "**habitat area**" and "**intermediate zone**"), "**microhabitat area**", and "**site**" (Heydari-Guran 2014: 31) (Figure 7 - Figure 9).

<table>
<tr><th colspan="2">Palaeolithic space</th><th>Descriptions</th></tr>
<tr><td colspan="2">Macrozone</td><td>A large geological and physiographical region (e.g., Zagros Mountains or Central Plateau).</td></tr>
<tr><td colspan="2">Ecozone</td><td>Highly heterogeneous in composition, with habitats varying widely in type and suitability (e.g., southern Zagros Mountains).</td></tr>
<tr><td rowspan="2">Home -range zone</td><td rowspan="2">A region composed of several habitat areas and intermediate areas that early humans move through during different seasons in the year as an annual home zone</td><td>Habitat area</td></tr>
<tr><td>Intermediate area</td></tr>
<tr><td colspan="2">Microhabitat area</td><td>A physical location that is home to one or more living or activity places, where various species/inhabitants interact.</td></tr>
<tr><td colspan="2">Site</td><td>The smallest geographical space used by humans for daily living activities.</td></tr>
</table>

Figure 7 - Physiographical classifications for Palaeolithic spaces of the Iranian Plateau (from Heydari-Guran 2014:33, table 3.1).

<table>
<tr><th colspan="2">Approximate scale Km^2</th><th colspan="2">Palaeolithic space</th></tr>
<tr><td rowspan="2">Large scale</td><td>>100,000</td><td colspan="2">Macrozone</td></tr>
<tr><td>10,000-100,000</td><td colspan="2">Ecozone</td></tr>
<tr><td rowspan="2">Medium scale</td><td>1000-10,000</td><td colspan="2">Home range zone</td></tr>
<tr><td>10-1000</td><td>Habitat area</td><td>Geology, microclimate, shape, connectivity, and fragmentation</td></tr>
<tr><td rowspan="2">Small scale</td><td>1-10</td><td colspan="2">Microhabitat area</td></tr>
<tr><td><1</td><td colspan="2">Site</td></tr>
</table>

Figure 8 - Physiographical classifications for Palaeolithic spaces of the Iranian Plateau (from Heydari-Guran 2014:33, table 3.1).

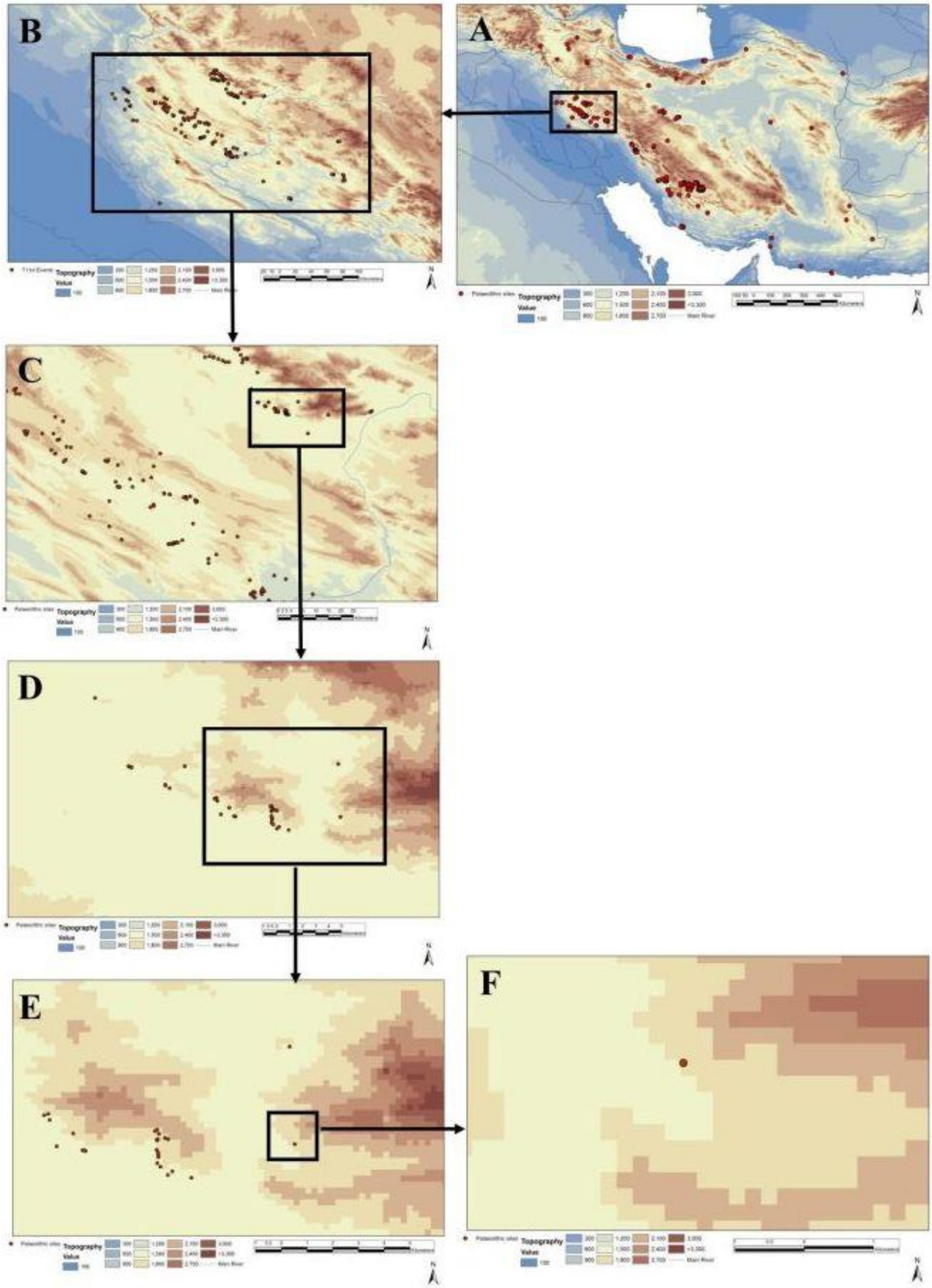

Figure 9 - Example of Heydari-Guran's hierarchical organization of physiographic units for defining Palaeolithic landscapes in Iran. A, Macrozone; B, Ecozone; C, Home-range zone (annual territory); D, Habitat area (site exploitation territory); E, Microhabitat area; F, Site. Dots represents Palaeolithic sites (from Heydari-Guran 2014:35, figure 3.2).

3.6.2 Macrozones

Heydari-Guran (2014: 31) divides Iran into eight macrozones (Figure 10). The largest of the tiers, macrozones are defined by geology, landform, and climate, as well as usually having a relatively consistent ecosystem. Moreover, macrozones can contain more than one ecozone.

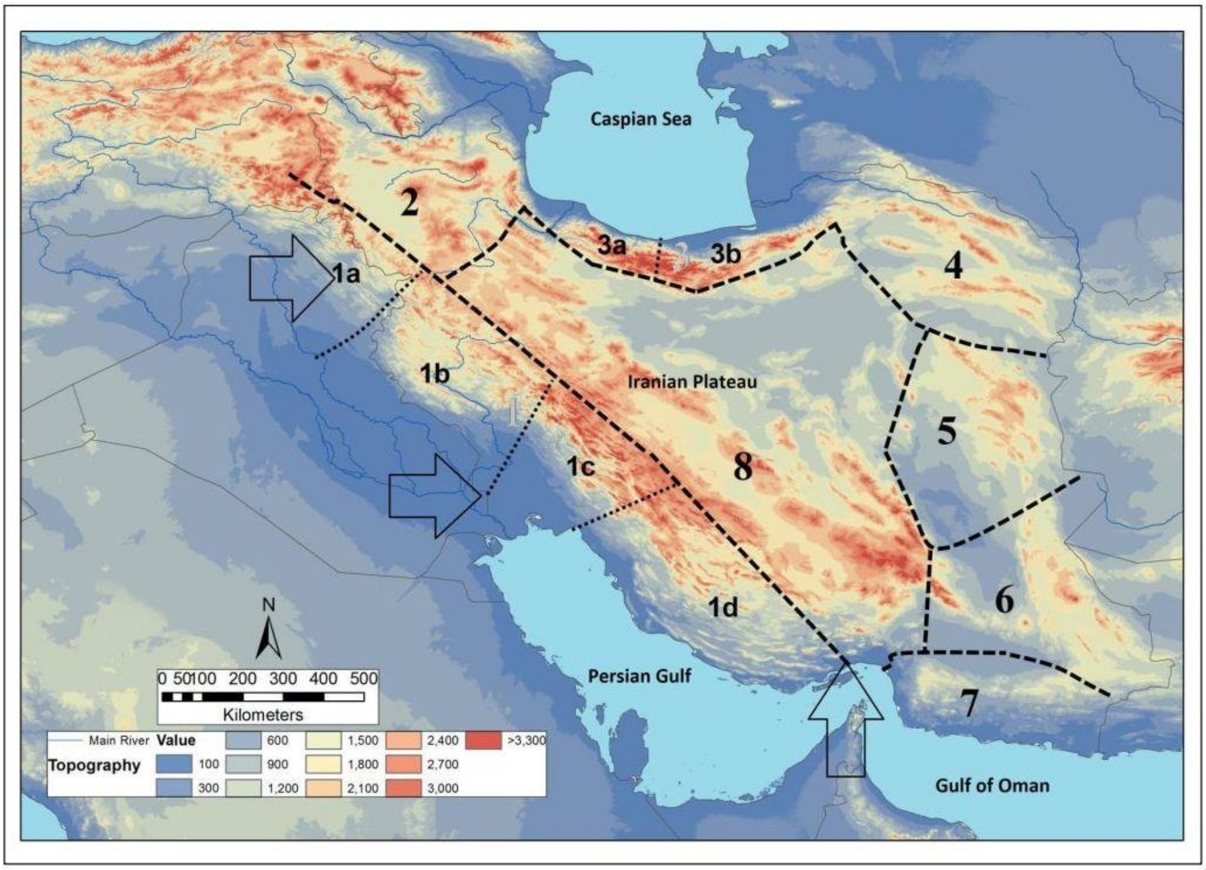

Figure 10 - Macrozones of the Iranian Plateau: 1, Zagros Mountain (1a, Northern Zagros; 1b, West Central Zagros; 1c, Central Zagros; 1d, Southern Zagros); 2, Northwest; 3, North (3a, West Alborz; 3b, East Alborz); 4, Northeast; 5, East; 6, Southeast; 7, Makran, and 8, Central Plateau (from Heydari-Guran 2014:32, figure 3.1).

3.6.3 Ecozones

An ecozone, as defined by Heydari-Guran (2014), is part of a macrozone, but based on its own individual sets of topographic and geological conditions. These conditions, which can be formed of hydrological networks, local climate, and topography, will also set them apart from adjacent ecozones. Ecozones can be of various sizes, and, if larger, can contain within them more than one home-range zone (Heydari-Guran 2014).

3.6.4 Home-range zone (annual territory)

Heydari-Guran (2014) adapts the concept of home-range zone from the behavioural study of ungulate mammals, and identifies it based on the distance hunter-gatherers would have to cover, in order to keep up with the movement of medium to large-size game. Home-range zones consists of two or more *habitat areas* exploited on an annual basis, and as such can be considered conceptually close to the definition of *annual territory* as classified by Vita-Finzi and Higgs (1970) (see also Lieberman 1993; Arroyo 2009) in their site catchment analysis (Heydari-Guran 2014: 31).

3.6.5 Intermediate zone

Paying close attention to physiography, Heydari-Guran (2014) describes how the physical structure of a home-range zone, like slope, water sources, and accessibility to shelters, defines the way multiple habitats within a home-range zone are composed, and through that influence how animals and hominins exploit that zone. An intermediate zone then is expressed as a transitional zone between two such habitats. These are areas considered to be either wholly uninhabitable or having been part of land-use patterns to a minor extent. Specifically, for game to occupy an area, sustenance must be present. For grasses, this requires stable conditions for soil formation to produce vegetation. Slopes with highly rocky and eroded surfaces thus frequently are characterised as an intermediate zone (Heydari-Guran 2014).

3.6.6 Habitat area (site exploitation territory)

Comparable to *site exploitation territory* in site catchment analysis, a habitat area is defined as a delimited space of resources occupied by game, and consequently by hominins. This is expressed by various environmental and ecological conditions and can vary in size. In this conceptualisation by Heydari-Guran (2014: 31-32), for hominins, a habitat area is suitable only in as far as game is present. This means that a habitat area ceases to work as a functional locale of exploitation as soon as the season(s), of which the game is dependent, change(s). A habitat area typically is made up of multiple *micro-habitat* areas (Heydari-Guran 2014).

3.6.7 Microhabitat area

In Heydari-Guran's (2014) classification, a micro-habitat area describes a geographical space within which one or more Palaeolithic sites are located, circumscribed by a clear landform boundary. Contained within such landform boundary a specific ecological or topographical affordance is provided, essentially spots on the landscape where inter-related subsistence tasks were more readily facilitated. What these spots have in common is a location close to one or more subsistence resources such as water or raw material, as well as access to game (Heydari-Guran 2014).

3.6.8 Site

The Palaeolithic locale of a site is considered by Heydari-Guran (2014) to be the smallest conceptualisation of space in his model. Two distinct types of sites are commonly recognised based on geology: shelter and open-air; with the former being divided into caves and rock shelters. Shelter sites are both the result of karstic rock decay, defined as dissolution of soluble rocks such as limestone or dolomite, as well as weathering, wherein natural hollows or cavities make occupation possible and desirable for both animals and hominins (Goldberg and Macphail 2006:169-187; Heydari-Guran 2014:33; Vardanjani et al. 2017). Caves and rock shelters are themselves distinguished by their geological structures, with the former characterised by a greater hollow space internally, and the latter being defined by a shallow concavity under an overhanging roof. Open-air sites, on the contrary, are not constricted by mountainous regions providing geomorphological conditions for habitations. While open-air and shelter sites are both associated with many of the same affordances for subsistence, the former can be less conspicuous on the landscape. Both open-air and shelter sites, however, are additionally identifiable though material cultural remains such as lithic scatters. Finally, sites are assessed by their individual physical characteristics, which is an accumulation of geological, hydrological, and ecological elements. In Heydari-Guran's (2014:33) model these include "*size, compass bearing of the shelter entrance(s), absolute elevation in meter above sea level (masl), accessibility, relative altitude (in meters above valley bottom), inclination of the slope, and access to the highland and the water sources*".

3.7 Site selection

In this thesis, three of my four sample sites are located in the Zagros Mountains. These are Shanidar Cave, and the rock shelters of Warwasi and Houmian. Accordingly, all three are located within the macrozone of the Zagros Mountains.

3.7.1 The macrozone of the Zagros Mountains

The longest mountain chain in Iran, the Zagros runs northwest-southeast for 1,500 km, from south-eastern Turkey/north-eastern Iraq/north-western Iran to the Strait of Hormuz in the south. It is underlain by carbonate rock formations (e.g. limestone and dolomite) prone to produce caves (Vardanjani et al. 2017:480) (see Figure 11 and Figure 12).

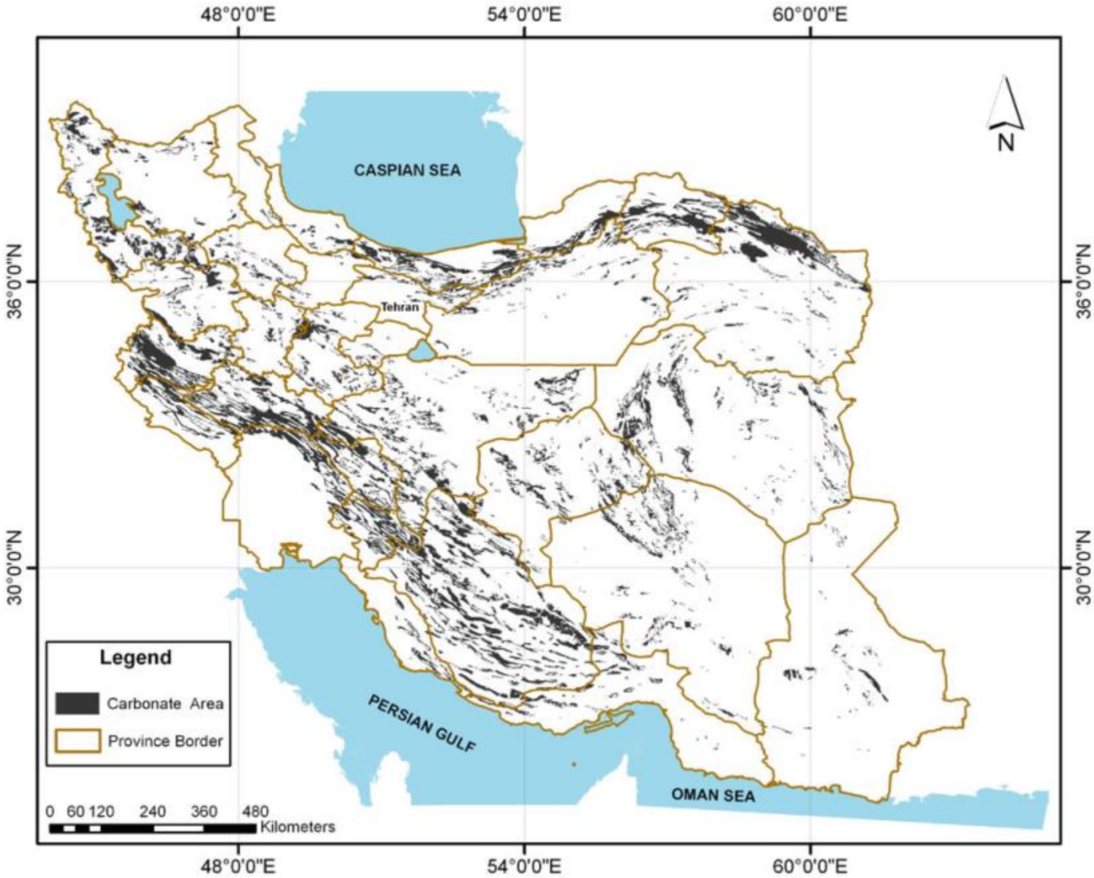

Figure 11 - Distribution of carbonate formations of Iran (from Vardanjani et al. 2017:480, fig. 1).

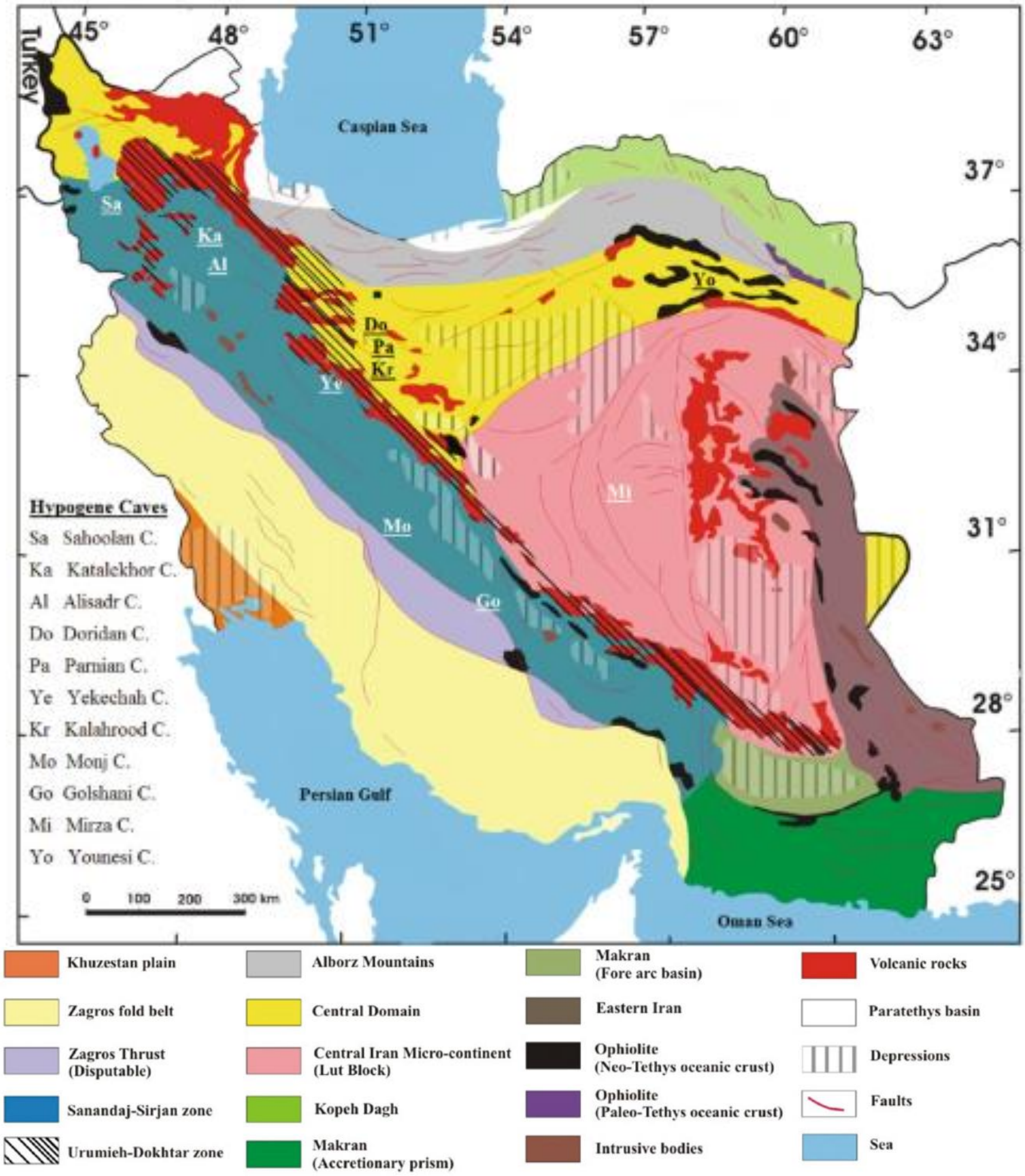

Figure 12 - Structural geology map of Iran (with list of hypogene caves not mentioned in text) (from Vardanjani et al. 2017:482, fig. 2).

Heydari-Guran (2014:31) classifies the Zagros Mountains as a single macrozone, due to its consistency in sedimentary makeup, drainage patterns, and climate. However, he does divide the Zagros into four distinct ecozones, labelled "Northern" (in Iraq), "West Central", "Central", and "Southern" (Heydari-Guran 2014:34). This is due to the fact that while all four zones enjoy a Mediterranean climate, the Central ecozone enjoys more rainfall. Another difference on the ecozone level is the existence and proliferation of intermountain plains, where the Southern ecozone have both more and larger-sized ones than the three northern ecozones, making it a more topographically open environment. As intermountain plains are conducive for drainage connectivity, Heydari-Guran hypothesises such features as being crucial for linking intermountain plains, thereby facilitating migration of game, which in turn attracted hominins (Heydari-Guran:31, 34).

3.7.2 The ecozone of the Northern Zagros Mountains

At ca. 36,000 km^2 the ecozone of the Northern Zagros Mountains is roughly situated in what is the Iraqi-Kurdistan region of Iraq, close to the Turkish and Iranian borders. This region is made up of three major tectonic zones. These are the *Thrust Zone*, the *High Folded Zone*, and the *Low Folded Zone* (Stevanović, Iurkiewicz and Maran 2009: 85-86) (Figure 13). The Thrust Zone is made up of geological formations ranging from pre-Triassic and Jurassic to late Tertiary (Cenozoic). The High Folded Zone originates in the late Lower Cretaceous and is predominantly constituted of carbonate (e.g. limestone and dolomitized limestone) and clastic rocks. In the Middle and Upper Miocene, thick layers of heterogeneous sediments, comprising marls, sandstones, anhydrite, gypsum, conglomerates, clays and sand were deposited. As such, tectonic features of the High and Low Folded zones are recorded as: "*the occurrence of long linear double plunging folds, with anticline structures such as mountain ridges and intermountain valleys in synclines between them*" (Stevanović, Iurkiewicz and Maran 2009: 85-86). The region is characterised as a foothills belt with linear ridges set between broad valleys or plains with the Mesopotamian lowlands to the west and the Zagros Mountains proper to the east (Wright 1952:11). Two main rivers, the Greater and Lesser Zab, constitute the main drainage of the region. The former runs for ca. 400 km from the vicinity of Lake Van in Turkey to its confluence with the River Tigris in Iraq, with a drainage basin estimated to cover ca. 40,000 km^2, or the equivalent of the entire ecozone of the Northern Zagros Mountains.

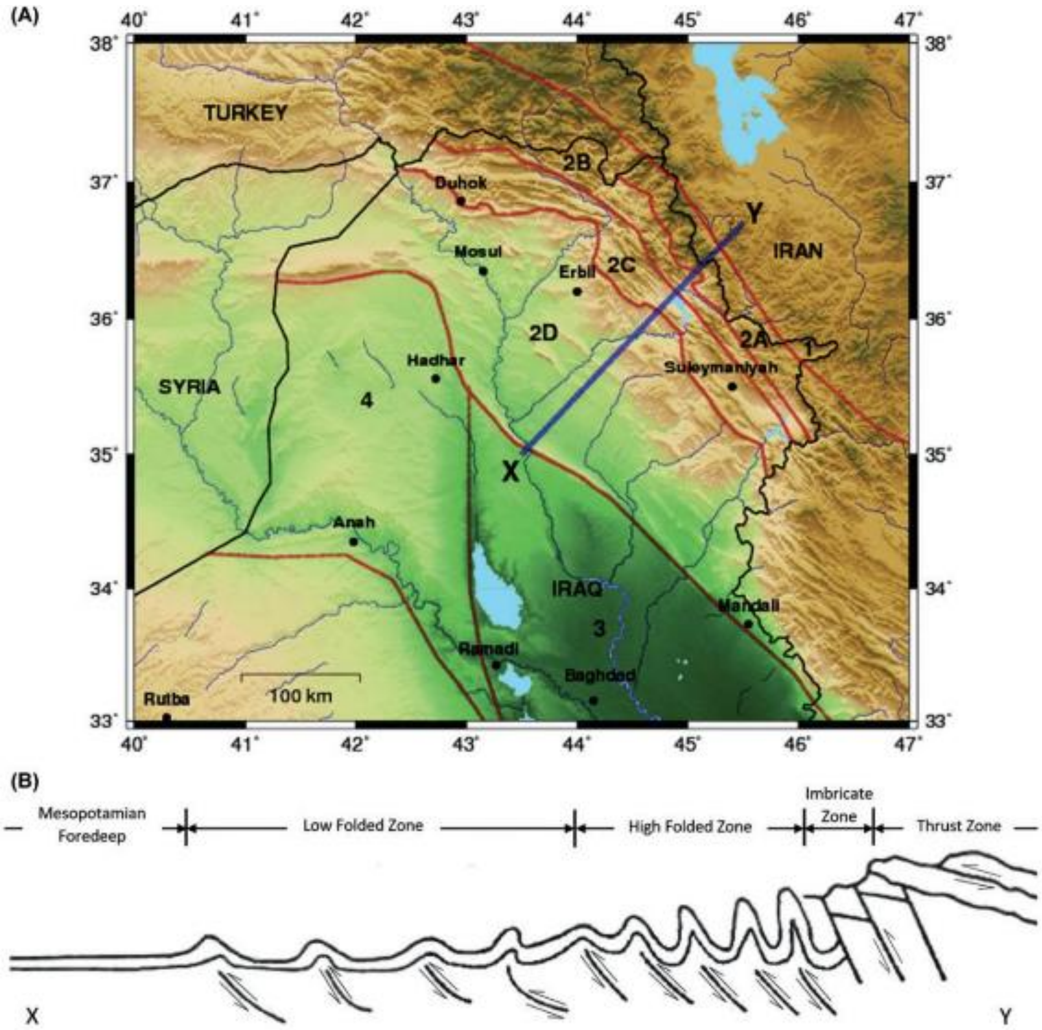

Figure 13 - (A) Tectonic divisions of the Zagros fold-thrust belt: 1, Sanandaj-Sirjan Zone; 2A, Suture/Thrust Zone; 2B, Imbricate Zone; 2C, High Folded Zone; 2D, Low Folded Zone; 3, Mesopotamian Plain; 4, Al-Jazira Plain. (B) Cross-section through the Zagros Fold-T Thrust Belt (northeast-southwest direction) (from Abdulnaby 2019:56, fig. 4.3).

3.7.3 Home-range zone of Rawanduz

Heydari-Guran (2014:34) identifies two main home-range zones, Rawanduz and Chamchamal, within the ecozone of the Northern Zagros Mountains. One of my sample sites, Shanidar Cave, is located in the Rawanduz Home-range zone (Figure 14).

3.7.4 Shanidar Cave

Shanidar Cave (N36.830271, E44.220786) is a karstic limestone cave, situated at 745 m a.s.l., about 2.5 km from the Greater Zab River (Solecki 1963; Heydari-Guran 2014:36; Reynolds et al. 2015) (Figure 15). Facing south (southern aspect), the mouth of the cave is about 25 m wide and 8 m high. About 40 m deep and a maximum width of 53 m, it commands a total surface area of ca. 1200 m^2 (Solecki 1963:179; see chapter 2 and 6).

3.7.5 Selection criteria

The selection of the site for this study was based on the author's participation in the renewed excavation of the site, the iconic status of Shanidar Cave in the Middle Palaeolithic research history, and because of the site's position at a low elevation relative to the other Zagros sites included in the study, Warwasi and Houmian. As such, Shanidar would serve as the lowest-lying sample site in the comparative lithic analysis, with which the author aimed to explore the viability of the Summer Adaptation Hypothesis. While "new" material (i.e. lithic assemblages from excavations 2014-present) was not available for analysis to the author, it was assumed, based on the available literature on the old collections, that these assemblages would be available through US museums. Unfortunately, at the time of this author's data collection, only the Smithsonian Institution collection could be accessed. The Columbia University collection, thought to include the "pointed tools" (Solecki and Solecki 1993), was unavailable.

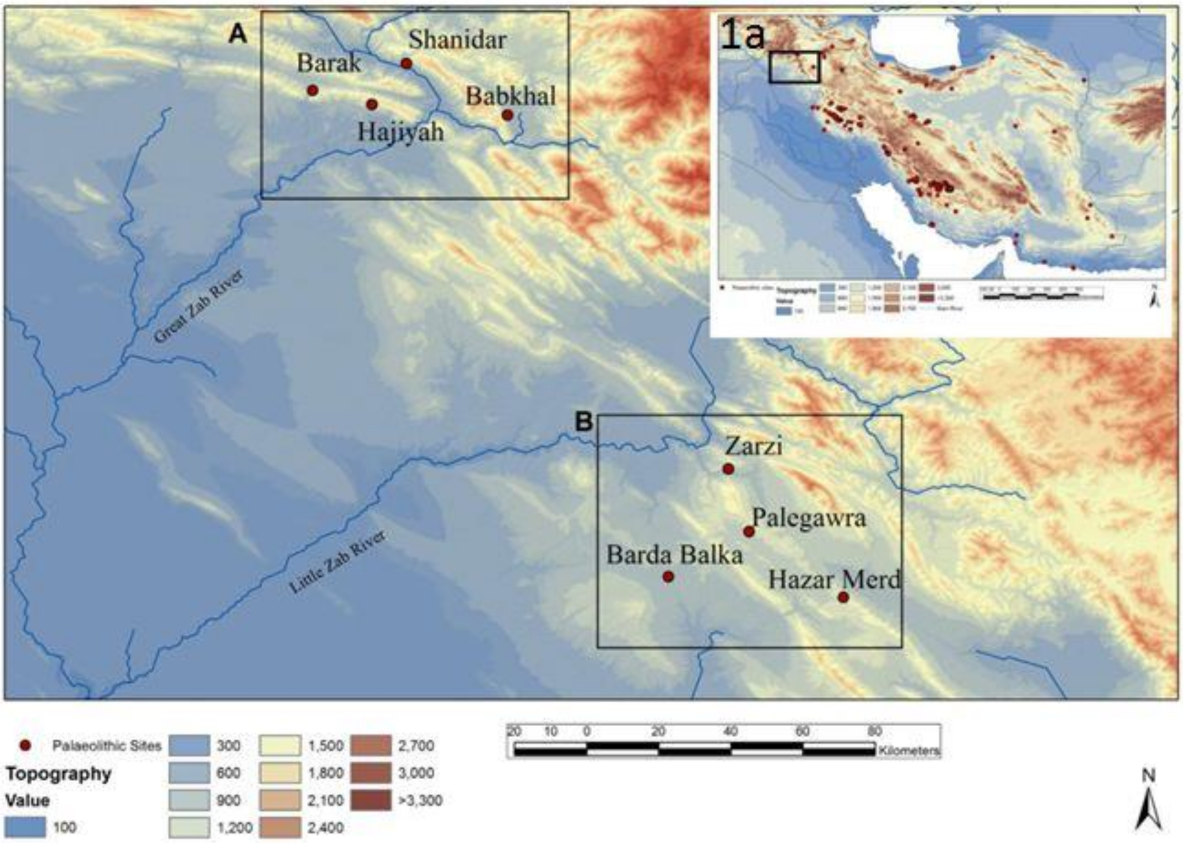

Figure 14 - Topographic map of the Rawanduz (A) and Chemchemal (B) home-range zones, with the rivers Greater and Lesser Zab, within the ecozone of the Northern Zagros Mountains (1a). Red dots denote known Palaeolithic sites with industries ranging from Middle Palae Palaeolithic to Neolithic (adapted from Heydari-Guran 2014:37, figure 3.3).

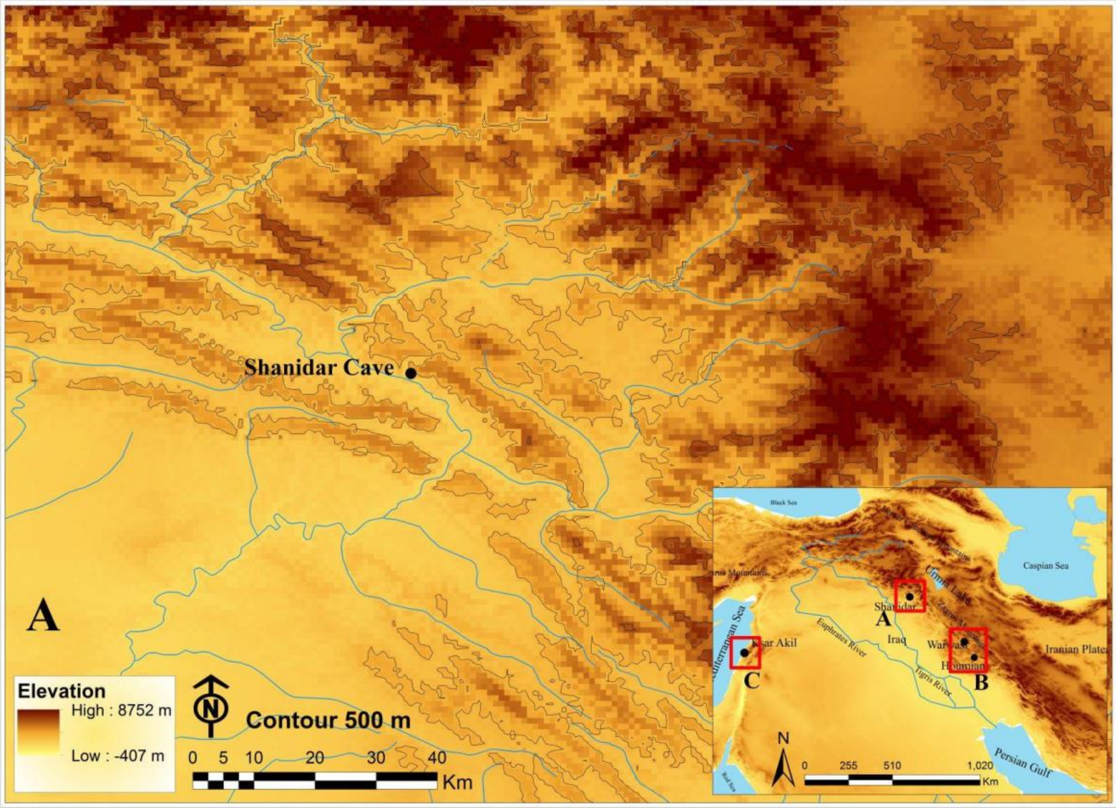

Figure 15 - Topographic map of the location of Shanidar Cave

3.7.6 The ecozone of the West Central Zagros Mountains

The ecozone of the West Central Zagros Mountains is wholly situated within north-western Iran, and located immediately southeast of the ecozone of the Northern Zagros Mountains. With its 200,000 km^2, it is about 5.5 times larger than its northern neighbour. Like the ecozone of the Northern Zagros Mountains, the ecozone of the West Central Zagros Mountains has a complex tectonic makeup (Alipoor et al. 2012; Vardanjani et al. 2017). This diversity is part of the foundation for climatic and environmental variability within the ecozone.

The ecozone comprises stretches of the "*Zagros Fold belt with … shelf deposits of Permo–Triassic to Late Cretaceous/Paleocene age …* [a] *'Crush Zone' (or High Zagros) with imbricated tectonic slices comprising Mesozoic limestones, radiolarites, obducted ophiolite remnants and Eocene volcanics and flyschs, which are all thrusted onto the ZFB* [Zagros Fold Belt]. *The Zagros fault, with the Main*

Zagros Thrust (MZT) separating the above domains from the so-called internal zones … *and the Main Recent Fault* [MRF] *partly cutting through earlier tectonic slices* (Agard et al. 2005:403-404).

These physiographic realities configurate natural boundaries in the form of hills and rocks, like for example synclines and anticlines. While the rising, convex formations of anticlines creates natural boundaries, the dipping geology of synclines create concave space in which valleys or rivers can establish (Vardanjani et al. 2017). It has been noted that the orientation of these synclines and anticlines not only dictates the axis of intermountain valleys, but further that this created differences in the topographical expression of the landforms, the home-range zones among, which in turn had implications for ungulate seasonal migration patterns and consequently hominins land-use and foraging strategies. Heydari-Guran (2014:40) notes that: "*Based on geological structures and landforms seen here, intermountain valleys fall into two different types: valleys formed along the anticlinal axis, having a northwest-southeast tendency, and ones formed on transverse stream formations, which have northeast-southwest leanings. Normally, wide plains appear within the anticlinal, while transverse valleys are narrow gorges. The Kermanshah Plain* … [is a] *classic examples of* [an] *anticlinal axis valley and the Khorramabad Valley is characteristic of a transverse valley*.

The ecozone is drained by the Karkheh Basin, through streams like the Qara Su and Gamasiab, the confluence of which creates the Seymareh River (Oberlander 1965; Mortensen 1974). Heydari-Guran (2014: 40) notes how the streams and rivers work to interconnect the various home-range zones of vast intermountain valleys and plains – some up to 4.900 km^2 (Brookes 1989:1) – in this particularly mountainous ecozone, through gorges and passes. Heydari-Guran (2014: 40-61) identifies multiple home-range zones, including Kermanshah and Luristan, and numerous habitat areas including those of Kermanshah and Kuhdasht, wherein the rockshelter sites of Warwasi and Houmian are found.

3.7.7 The home-range zone of Kermanshah

The home-range zone of Kermanshah is situated within the Paraw-Shahoo ranges of the Zagros, an area unusually rich in karstic caves and topographic relief (Waltham and Ede 1973) (Figure 16). It includes both the habitat areas of Kermanshah and Bisitun, which contains the sites of Warwasi and Bisitun, respectfully. Set within the Seymareh basin, it is orientated northwest-southeast, and, functioning as a corridor sustained by rivers, streams and springs, is connected to the home-range zone of Luristan, through steep gorges between the Kermanshah and Hulailan habitat (Heydari-Guran 2014:40-43; Waltham and Ede 1973).

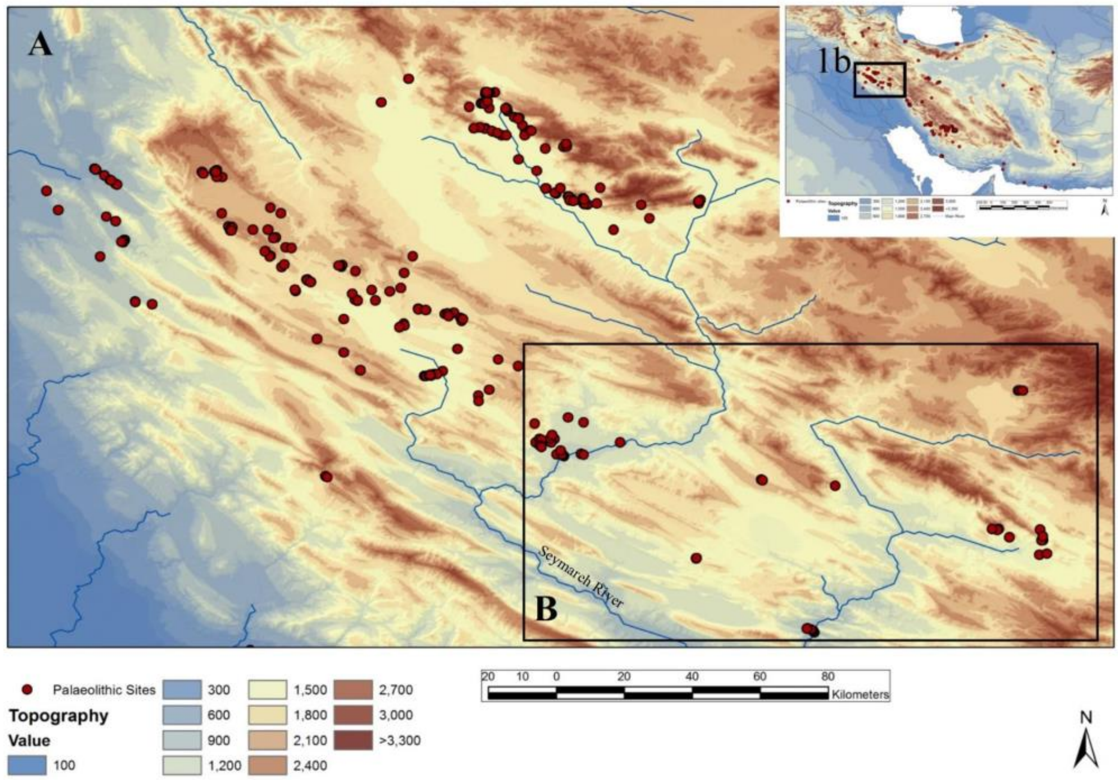

Figure 16 - Topographic map of the Kermanshah (A) and Luristan (B) home-range zones, with the Seymareh River, within the ecozone of the West Central Zagros Mountains. Red dots denote known Palaeolithic sites with industries ranging from Lower to Epi-Palaeolithic (f from Heydari-Guran 2014:41, figure 3.7).

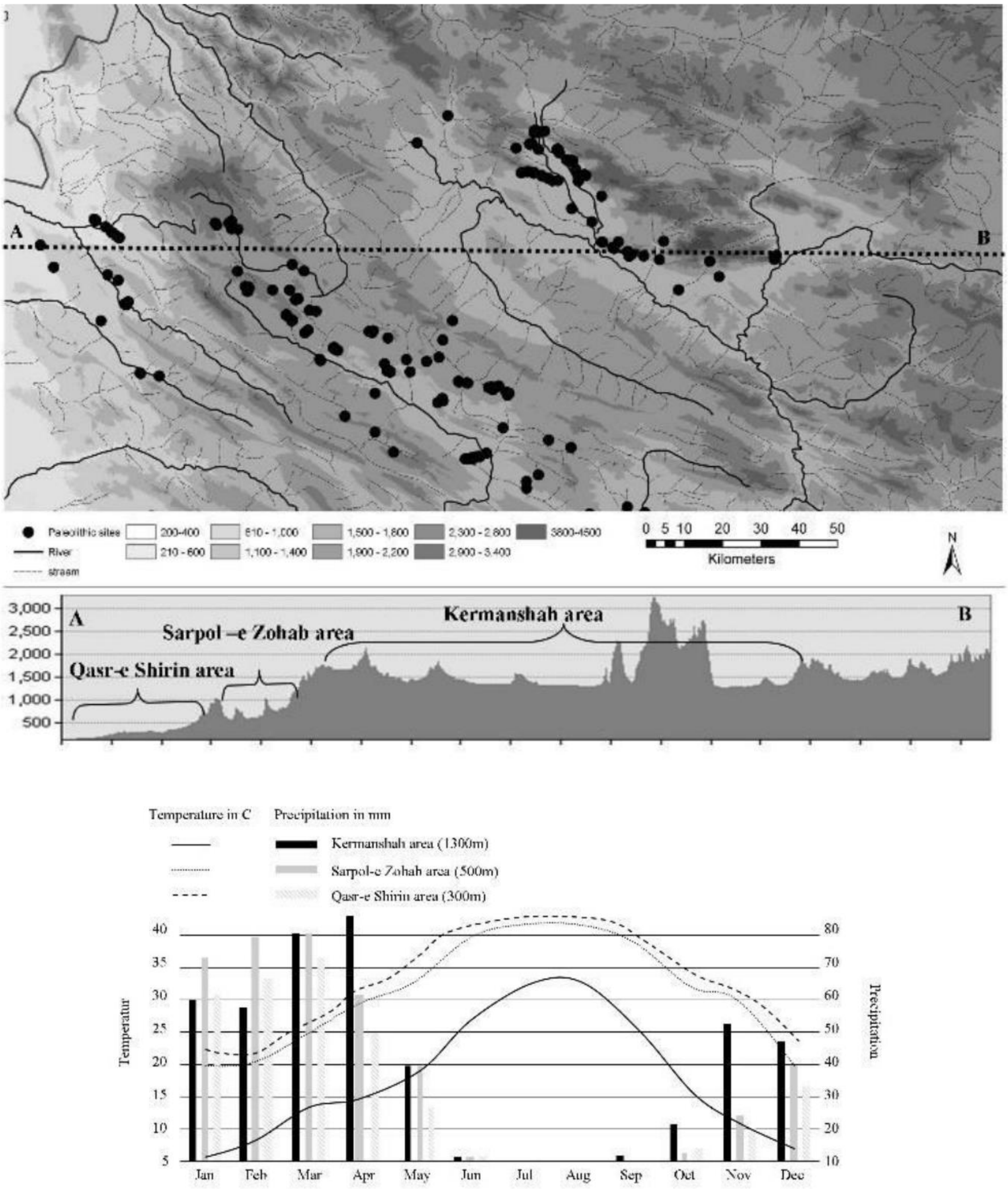

Figure 17 - Topography of Kermanshah home-range zone with habitat areas (upper); cross section of elevation of Kermanshah habitat area relative to neighbouring ones (middle); modern temperature and precipitation ranges for Kermanshah habitat area relative to neighbouring ones, facilitating in-zone ecosystem differentiation (lower) (from Heydari-Guran 2014:44, figure 3.9).

3.7.8 The habitat area of Kermanshah

The habitat area of Kermanshah is situated around 1300 m a.s.l., in a range with elevations up to 3300 m a.s.l. Located in the middle of the Kermanshah home-range zone between the habitat areas of Ravansar and Bisitun, it functions as an east-west corridor, through transverse valleys like the Tang-i-Knesht, in which Warwasi is located (Heydari-Guran 2014:43) (Figure 17).

3.7.9 Warwasi rockshelter

Warwasi rockshelter (N34.3897, E47.1656) is located about 11 km from Bakhtaran in the Tang-i-Knesht Valley, ca. 1300 m a.s.l. (Dibble and Holdaway 1993; Tsanova 2013; see chapter 2 and 7) (Figure 18).

3.7.10 Selection criteria

After its belated publication by Dibble and Holdaway (1993), the Middle Palaeolithic lithic collection from Warwasi, while lacking proxy data such as chronometric dates and environmental studies, represent one of the best repositories of Middle Palaeolithic assemblages from the Zagros available for comparative analysis. In this study, it is selected to represent a middle elevation relative to Shanidar Cave and Houmian, in the examination of the Summer Adaptation Hypothesis. Other Zagros assemblages (Kobeh, Kunji, and Gar Ajarneh) were unavailable due to various logistic issues, and the Bisitun assemblage was considered too heavily-curated to afford any useful data for this study.

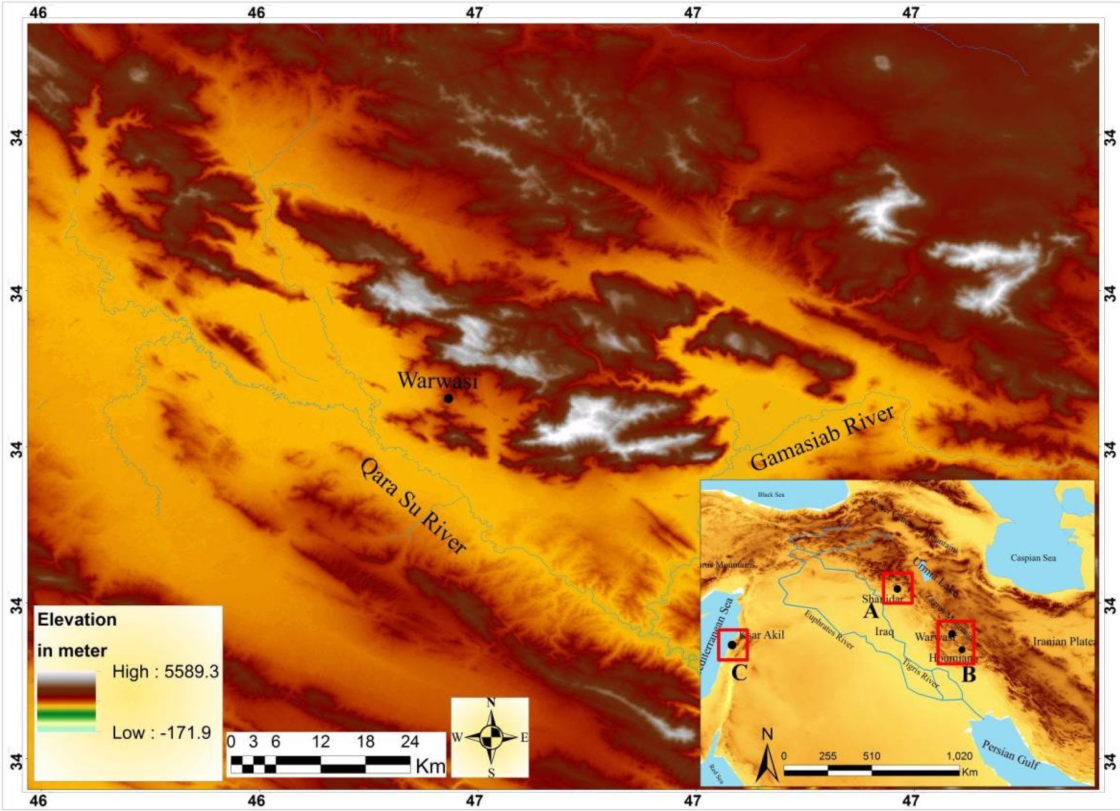

Figure 18 - Topographic map of the location of Warwasi rockshelter

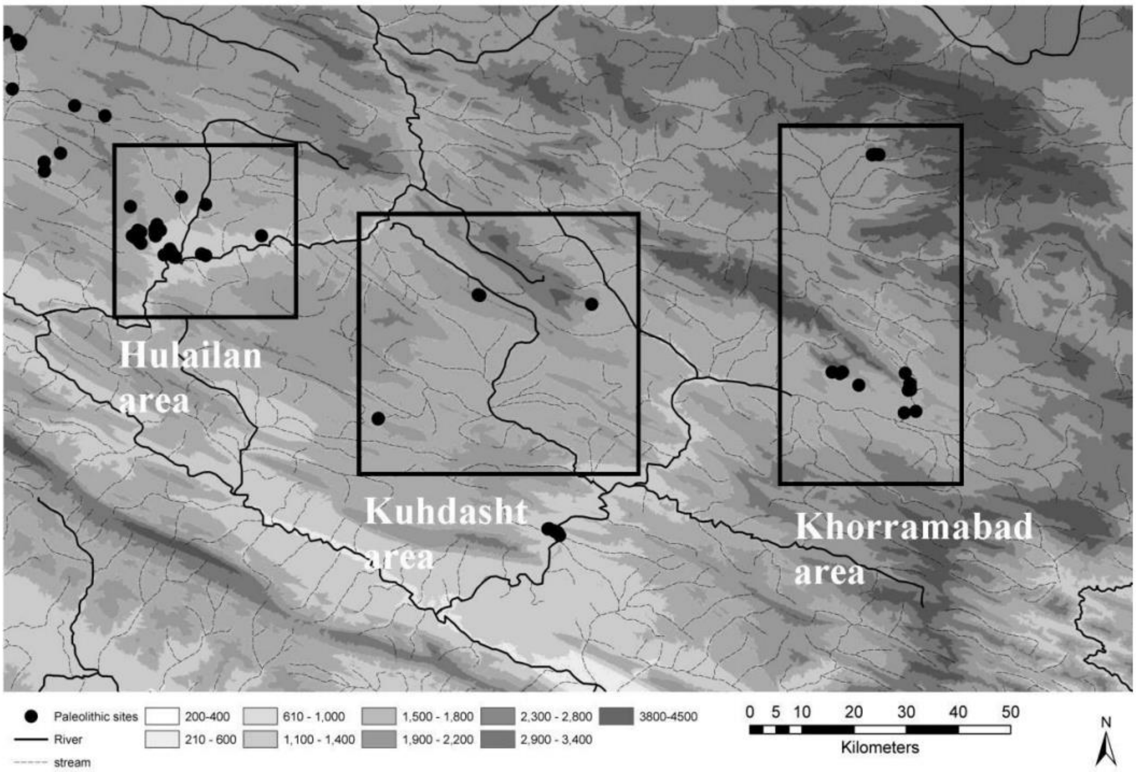

Figure 19 - Topographic map of the Luristan home-range zone, with the Hulailan, Kuhdasht, and Khorramabad habitat areas. Black dots denote known Palaeolithic sites with industries ranging from Middle to Epi-Palaeolithic (from Heydari-Guran 2014:55, figure 3.19).

3.7.11 The home-range zone of Luristan

The home-range zone of Luristan (Figure 19), to the south of the home-range zone of Kermanshah, incorporates around 12,000 km^2 of intermountain plains, among which are Hulailan, Kuhdasht, and Khorramabad (Heydari-Guran 2014:54-62). Many Palaeolithic sites are found here, such as Kunji Cave (e.g. Baumler and Speth 1993), Yafteh Cave (e.g. Tsanova 2013), and Houmian (Bewley 1984).

3.7.12 The habitat area of Kuhdasht

The habitat area of Kuhdasht is an intermountain plain of around 625 km^2, located in the Zagros Folded Zone between two anticlines, about 60 km west of the habitat area of Khorramabad (Heydari-Guran 2014:59).

3.7.13 Houmian rockshelter

The Houmian rockshelter (N33.6403, E47.6043) is situated on the limestone ridge of Sarsukhan, at the great altitude of 2000 m a.s.l. according to Bewley (1984:1; 1800 m a.s.l., Leroi-Gourhan 1981) (Figure 20). The name of Houmian possibly is taken from the name of the valley below it (Bewley 1984:1), described by Goff (1980:35) as "*a deep well-wooded trough, rimmed by low vertical cliffs situated in the northern side of the Sarsukhan ridge*" Goff (1980:28 in Bewley). Bewley (1984:1-2) describes the setting of the site follows: "*The ridge between the valleys of Houmian (to the north-east) and Diyali (to the south-west) is called the Sarsukhan by Goff, and is probably a syncline of limestone. The anticlines have been eroded away on both sides, leaving deep troughs with (in Houmian's case) exposed pebble beds as well as limestone cliffs. The top of the ridge at its widest is 6 km and up to 2000 m above mean sea level … It is bounded to the north by the Saimarreh river and the Holailan plain, and to the south by the plain around Kuh-i Dasht rand the Kashgan river*."

3.7.14 Selection criteria

The attention of the author was directed at the Middle Palaeolithic lithic assemblage from Houmian, when he was assessing what lithic collections from the Zagros could be accessed for comparative analysis. The combination of the lack of scientific discussion of the assemblage since 1984, together with its published environmental proxies (Bewley 1984; Leroi-Gourhan 1981) and un-curated lithic assemblage (i.e. including small debitage), as well as its prominent elevational setting, it was considered ideal for inclusion in this thesis to represent an upper point of reference. As such, in this study, it is selected to represent the highest-lying elevation relative to Shanidar Cave and Warwasi, in order to achieve the objective of exploring the Summer Adaptation Hypothesis.

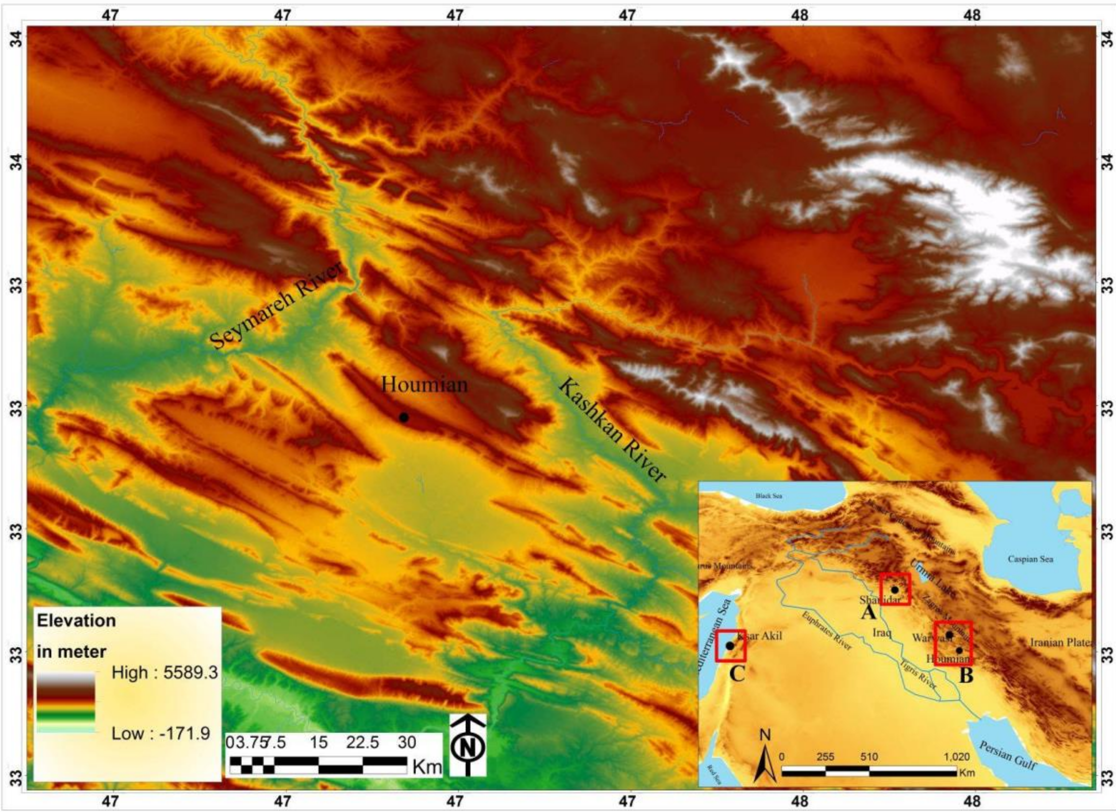

Figure 20 - Topographic map of the location of Houmian Rockshelter

Chapter 4 - Approaches and Methods

4.1. Introduction

4.1.1 Aims and objectives

The objective of the construction of a methodological framework is to equip the analytical process with a set of tools able to appreciate specific taphonomic histories and technological characteristics within each lithic assemblage. Identifying the inherent variability within an assemblage allows the specific composition to be explained through a behavioural framework grounded in social theory (e.g. Shanks and Tilley 1988) and relevant ethnoarchaeological analogy (e.g. Binford 1977, 1979, 1983). The objectives of the methodology are to collect a substantial number of technological attributes, as well at typological and taphonomic information. The aims are, firstly, to use the individual combined datasets to ascertain the techno-typological variability within each sample assemblages from the Zagros. Evaluating individual assemblage based on variables asserted to be specific or common within a Zagros Mousterian context, such as amount of retouch, Levallois, pointed tools, and truncated-facetted pieces, the methodology will supply a clear representation of the lithic variability. Secondly, the data gathered from the Levantine Mousterian site of Ksar Akil, will act as a comparative assemblage. The same attribute analysis will be applied to this collection, and the aim is a coherent dataset able to demonstrate to what degree the three Zagros sites are homogenous in their techno-typological appearance, and to what extent they differ from the Levantine assemblage.

4.1.2 Methodological choices

As assemblage resolution for various reasons differs a lot between excavated sites in southwest Asia, some collections will preserve a larger proportion of the complete reduction sequence than others. For this reason, it is not always possible to apply the same level of analytical scrutiny to every assemblage. From some sites, predominantly those excavated during the first part of the last century, lithics are sometimes preserved mostly as core and tool assemblages, when debitage deliberately have not been curated by excavators. Conversely, sometimes site-use is attested solely by debitage. In each such instance, where the analytical possibilities are limited, explanatory options are equally limited. In this respect it is necessary to think about how we look at lithic assemblages, and through which parameters we seek to contextualise them. The assemblages chosen for this study, both those from the Zagros, and the one from the Levant, was excavated in a period of archaeological research, where much contextual data is unavailable. Due to the very low resolution of stratigraphic information for the assemblages from all but Houmian, it was decided to utilise a methodology geared to a type of assemblage usually analysed on its own, namely surface collections. Though not equating the assemblages selected in this thesis with surface collections, the approach was considered appropriate. This involves taking into consideration the fact that resolution of debitage likely will not be great, and that e.g. retouched tools might be more prevalent in these assemblages compared to their original distribution due to post-excavational curation.

4.2 Methodology for recording lithics

4.2.1 Taphonomy

Determining the taphonomic integrity of a lithic assemblage is important, as it allows the insight as to whether the artefacts under study have been deposited in more than one episode of discard, i.e. contextually speaking constitutes more than one assemblage. This is important, as a mixture of assemblages will skew the analytical value of the research. This is more relevant in assemblages where stratigraphical control is disputed or known to be unsecure. To reveal this potential admixture, lithics must be submitted to a taphonomic assessment. The methodology employed in this study, including both taphonomic assessment and subsequent attribute analysis, is based on work by Jones (2007), Scott (2011), and Shaw (2012).

All artefacts should be subjected to an assessment of individual physical condition in order to appreciate the taphonomic history (or histories) evident at the site. As such, the effects of aeolian or fluvial rearrangement are commonly argued to be evidenced by abrasion, edge damage, scratching, and battering (e.g. Shackley 1974; Schick 1986; Hosfield et al. 2000). Where evidence of such damage is apparent the degree is noted within a four-tiered classification.

Besides physical alteration suffered through mechanical action, chemical alteration of the surfaces of lithics (Stapert 1976; Burroni et al. 2002) in the form of patination should also be recorded. Patination is believed to pertain to depositional context, i.e. specific burial environment or surface exposure (or both). For this reason, it has been argued (Shaw 2012) that chemical surface alteration might possess the potential to reveal different taphonomic histories for artefacts.

Categories of physical alteration will be classified in four stages: 'absent', 'light', 'moderate' and 'heavy'. These four stages are distinguished through observed proportion of coverage.

Recording of attributes is conducted by naked eye, aided by hand-held LED magnifying glass (30x22 mm 60x12 mm). Measurements are taken using a Mitutoyo Absolute AOS Digimatic calliper with digital USB interphase. Due to time constraints, measurements are taken only once. While this poses a risk of recording error (Dibble and Bernard 1980; Bingham and McNabb 2013), the decision is to focus on quantity in lithics recorded, rather than measuring the same piece repeatedly.

Digital Brifit Pocket Scale (500g x 0,01g) was used for weighing debitage. Digital Eono Scale (5kg-1g) was used for weighing cores. These were used for all assemblages.

4.3 Attributes for all artefacts

4.3.1 Qualitative variables relating to condition

Edge rounding: Edge rounding (through abrasion) refers to the degree to which edges of artefacts are rolled i.e. have been ground down through aeolian, fluvial, or other mechanical post-depositional movement. The level of alteration should not be considered proportional to the length of time an artefact has endured post-depositional modification, and as such only provide qualitative information towards the degree of such modification, not a secure chronological indication.

1) Absent
2) Light
3) Moderate
4) Heavy

Edge Damage: Edge damage is recorded as the degree of damage visible to the cutting edges of an artefact. The degree of chips and natural breaks not related to retouch. Contrary to edge rounding, edge damage will not result in 'dulling' of the edges of a lithic, and can appear as a single break whereas the level of edge rounding usually will be constant across the entire surface of an artefact.

1) Absent
2) Light
3) Moderate
4) Heavy

Patination: Patination and its meaning for the artefacts on which it occurs is a somewhat contested subject as mentioned above. In this study it has been recorded as macroscopically visibly chemical alteration, usually (but not always) with a 'smoother' surface than the unpatinated areas. It is noted that the occurrence of patination is not consistent across raw material. As such cryptocrystalline material like chert, flint, and chalcedony is more easily affected than metamorphic rocks like quartzite.

Degree of patination:

1) Absent
2) Light
3) Moderate
4) Heavy

Recycling: A piece is considered recycled if it shows one or more episodes of flake detachment from a previous knapped and patinated surface, i.e. if a "fresh" (unpatinated) flake scar has been detached from a knapped and patinated surface. By contrast, resharpening is considered to be conducted by the same knapper, or, alternatively, by a different knapper within a limited timeframe. This should not be long enough for a piece to acquire a patina.

1) Yes
2) No

Heat affected: A piece is considered heat affected if it shows signs of having been exposed to fire. This is detectable as crazing, a pattern of small cracks and fissures in the surface of the lithic giving it a marble-like texture. Another tell-tale sign of exposure to fire is potlids. Potlids are identified as round or semi-round holes, usually away from the edge of a flake, created by heat exposure.

1) Yes
2) No

Weight (g): Weight was rounded up or down to the nearest gram.

4.3.2 Qualitative variables relating to raw material

Raw material type:

1) Chert
2) Limestone
3) Quartzite
4) Obsidian
5) Chalcedony
6) Quartz
7) Unidentified

Raw material quality: Raw material quality differs. Obsidian would be considered 'very high', chert and chalcedony 'high' quality. Other types of raw material would be graded moderate to low, based on appearance.

1) Low
2) Moderate
3) High
4) Very High

Probable raw material source: Whether the artefact can be said to be made on raw material either obtained directly from its source of outcrop or on a secondarily available nodule like such found within river gravel. This is attested by remnant cortex. According to White (1998) it is possible to source flint/chert if a given artefact retains evidence of fresh, unrolled cortex. Whether raw material can be shown to come from nearby river gravel or from far away tabular outcrops, can help provide insights about land-use and mobility patterns. If rich, nearby sources of good raw material was readily available to hominins at high altitudes, it would not be necessary to economise with raw material, which is one of the main tenets in the "Summer Adaptation Hypothesis".

1) Fresh (evidence of fresh, unrolled cortex)
2) Derived (cortex is clearly rolled)
3) Indeterminate (no remnant cortex, or otherwise indeterminable)

4.3.3 Qualitative variables relating to technology

Mode of percussion: This refers to the particular technique of percussion used to detach or shape an artefact (e.g. Andrefsky 2005). The reason for recording mode of percussion lies in each mode's relative association with specific reduction techniques and techno-typological products, for example hard hammer percussion for Levallois reduction.

1) **Hard:** Hard-hammer knapping is recognized by a thick butt, a prominent bulb of percussion, and usually a distinct cone of percussion. The negative scars from hard-hammer knapping will evidence the same characteristics.
2) **Soft:** Soft-hammer knapping is recognized by a thin, wide, often lipped butt and will have an arched or bending appearance when seen in profile. The bulb of percussion is diffuse. The negative scars from soft-hammer knapping will evidence the same characteristics.
3) **Mixed:** If an artefact can be proved to have been knapped using both hard- and soft-hammer modes, it should be recorded as mixed.
4) **Indeterminate:** Occasionally, an artefact will have a scar pattern which is both suggestive of hard- and soft-hammer percussion, but which cannot be distinguished to a satisfactory degree. In such a case, the mode of percussion is recorded as indeterminate.

4.4 Flake attributes (non-Levallois)

Unretouched non-Levallois flakes have been separated analytically from flakes evidently resulting from prepared core reduction like the Levallois technique. This is done as non-Levallois flakes technologically can be the outcome of a range of reduction strategies, including the Levallois method (Copeland 1983, 1995; Marks and Volkman 1986: 14; Boëda 1995; Meignen 1995). For this reason, and without successful refitting, non-Levallois flake assemblages can only be indirectly associated to the prepared core assemblages through the recording of specific attributes. By looking at cortex retention it is possible to recognize which stage of production the assemblage represents. Likewise, the measuring of size of the flakes will inform about the general volume of cores and how much of the original reduction sequence the material represents.

4.4.1 Flake typology

The terminology used for describing debitage distinguishes between flakes, blades and bladelets *sensu lato*, i.e. in the metrical sense, not the techno-typological sense. Therefore, unless specifically stated, the term "blade" does not refer to products from prismatic core reduction, but rather signifies a "metrical blade", i.e. a flake twice as long as it is wide. "Bladelets", likewise, are small metrical blades, not exceeding 40mm in length. Similarly, the term "flakes" will be used as a catch-all phrase for the total assemblage, with the term "metrical flakes" (i.e. not metrical blades or metrical bladelets) used specifically to distinguish flakes from other debitage, unless specific contextual information makes it obvious e.g. 'redirection flakes'.

4.4.2 Quantitative variables

Flake length P (mm): Measured along the axis of percussion, from the point of percussion to point at the distal to distal margin.

Maximum flake width (mm): Refers to the maximum width of a flake at 90° to the axis of percussion.

Flake length P Max (mm): Measured along the axis of percussion, from the point of percussion to point at the distal to distal margin. If flake maximum length at distal is not parallel to the axis of percussion, i.e. if it is off-set either to the right or left lateral, a virtual perpendicular line is established from the (off-set) point of maximum distal length to the line parallel to the axis of percussion. This maximum measurement is then recorded. This measurement is easily taken with a calliper.

Thickness P (mm): Measured at same point as medial width.

Platform width (mm): Width of flake platform.

Platform thickness (mm): Platform thickness as measured through point of percussion at right angles to platform width.

Exterior platform angle: Angle between striking platform and dorsal surface.

Dorsal scar count: Count of the number of dorsal scars. Only scars with a minimum dimension of at least 5mm are included.

4.4.3 Qualitative variables

Platform surface (butt type): The type of platform surface (or butt) on a flake allows an insight into the mode of preparation by which a specific flake was detached. For example, a single conchoidal (or plain) platform without cortex shows that at least the immediate surrounding core platform was non-cortical, whereas a cortical flake platform proves a flake to stem from the primary reduction sequence of decortication or core platform preparation. Distinction between twelve unique butt types – prepared or naturally occurring – was made for non-Levallois flakes.

1) Plain
2) Dihedral
3) Cortical
4) Natural (but non-cortical)
5) Marginal (struck from core edge, forming narrow, indeterminate butt)
6) Soft hammer
7) Mixed (e.g. combination of natural and flaked surfaces)
8) Facetted
9) Missing
10) Trimmed (characterized by small flake scars running into dorsal surface along same axis as flake itself)

11) Obscured (e.g. by damage)
12) Retouched
13) Chapeau de Gendarme

Flake termination:

1) Feather
2) Hinge
3) Step
4) Plunging/overshot
5) Axial
6) Retouched

Dorsal scar pattern (knapping pattern): Refers to the direction of detachment of previous flakes on the dorsal face of a flake. Figure 21 illustrates a novel method of classifying dorsal scar patterns introduced in this thesis.

1) From proximal: scars are initiated from proximal end (unidirectional from proximal).
2) From distal: scars are initiated from distal end (unidirectional from distal OR bidirectional by proxy (*sensu* Tostevin 2012: 128)).
3) Indeterminate (but unidirectional from proximal or distal (e.g. only one dorsal scar)).
4) From right: scars are initiated from right lateral.
5) From left: scars are initiated from left lateral.
6) Indeterminate (but unidirectional from right or left lateral (e.g. only one dorsal scar)).
7) Bidirectional, from proximal and distal: scars are initiated from opposing directions from proximal and distal.
8) Bidirectional, from lateral: scars are initiated from opposing directions from right and left laterals.
9) Indeterminate (but either uni- or bidirectional from proximal or distal, i.e. scars from maximum two AND opposed directions).

10) Indeterminate (but either uni- or bidirectional from lateral, i.e. scars from maximum two AND opposed directions).
11) Multi-directional: scars are initiated from either proximal/distal and either right/left lateral (e.g. flake scars initiated from proximal and from right lateral).
12) Weakly radial ("Subcentripetal" *sensu* Adler 2002: 40; Tostevin 2012: 128, "Subradial" *sensu* Baumler 1987: 245): scar pattern is weakly radial if flake scars are present, initiated from three different directions.
13) Strongly radial: scar pattern is strongly radial if flake scars have been initiated from four different directions ("Centripetal" *sensu* Tostevin 2012: 128) OR at least three different directions and cover 360 degrees (i.e. no cortical edges/surfaces are present).
14) Indeterminate (but radial).
15) Arrised radial: Radial scars meet in the middle of the dorsal face to form a central ridge.
16) Crested: Initiation blade of blade production.
17) Wholly cortical.
18) Obscured (e.g. by post-depositional crust).
19) Indeterminate.
20) Retouched: dorsal scar pattern obscured by retouch.

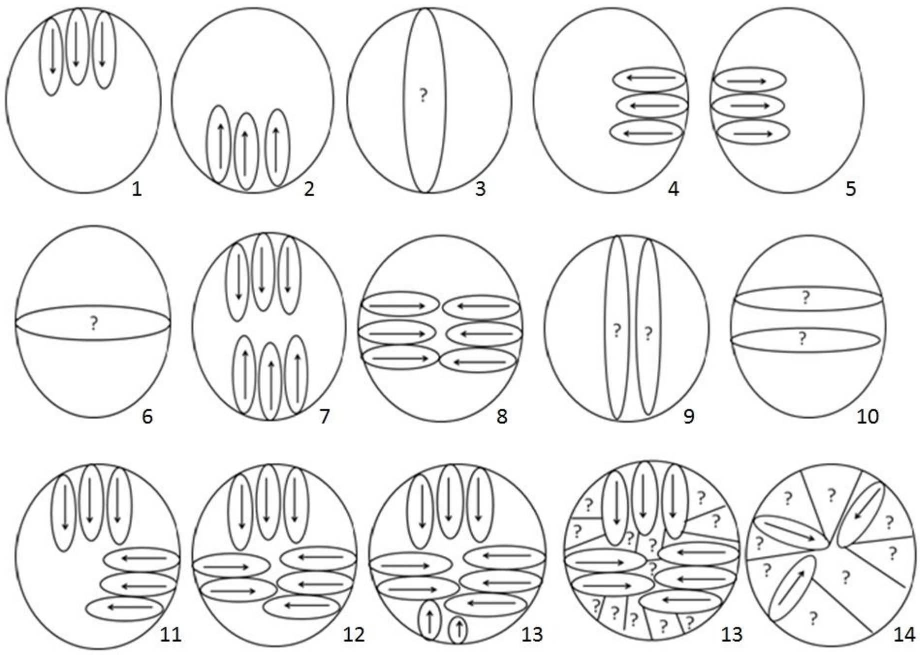

Figure 21 - Dorsal scar pattern (knapping pattern), No. 1-14.

Dorsal cortex on flake: Recording of the extent of cortex or any natural surface residual on the dorsal face of the flake. Estimation made by eye.

1) 0%
2) 1-25%
3) 26-49%
4) ca. 50%
5) 51-75%
6) 76-99%
7) 100%

Flake cortex location: Specify the location of cortex on flake.

1) Dorsal only
2) Platform only
3) Dorsal and platform

4) None

Portion of flake: The importance of a flake being recorded as whole, or broken in a specific way, is paramount to the information that can later be drawn from it. For example, for most analyses only whole flakes are included. On the other hand, a large occurrence of proximal and/or mesial, and distal flakes within an assemblage could potentially be indicative of selective preference by the knapper(s) or post-depositional damage:

1) Whole
2) Proximal
3) Mesial
4) Distal
5) Longitudinal (Siret): flake has split along or parallel to the axis of percussion.

Pointed: Is the artefact pointed? Measured along the technological axis, an artifact is considered pointed if a) the left and right laterals are convergent at distal either by retouch or by detachment, or b) the left lateral is pointed due to right lateral converges towards left lateral, either by retouch or detachment, or c) the right lateral is pointed due to left lateral converges towards right lateral, either by retouch or detachment.

1) No
2) Yes, by debitage
3) Yes, by retouch
4) Yes, by break/snap

Redirection flake (relict core edge): A redirection flake shows remains of the (proximal) instigation(s) of flake scar(s) on its dorsal surface, oriented in a different direction than the flakes current platform. This is evidence for a relict core edge. A flake with a relict core edge is indicative of core rotation where the current flake has been struck in order to create a new platform for flake detachments (Clarkson and O'Connor 2006: 174-175).

1) Present
2) Absent

Flake typology:

1) Flake
2) Broken flake
3) Blade
4) Broken blade
5) Bladelet
6) Broken bladelet
7) Flake spall
8) Levallois flake
9) Broken Levallois flake
10) Levallois blade
11) Broken Levallois blade
12) Levallois point
13) Broken Levallois point
14) Debordant flake
15) Broken Debordant flake
16) Redirecting flake
17) Broken Redirecting flake
18) Redirecting blade
19) Broken Redirecting blade
20) Redirecting bladelet
21) Broken Redirecting bladelet
22) Crested blade
23) Broken Crested blade
24) Crested bladelet

25) Broken Crested bladelet

26) Kombewa flake

27) Broken Kombewa flake

Retouch: Is the artefact retouched or not. If it is, the specific kind and amount of retouch is described in the retouched artefacts section (see below).

1) Yes
2) No

4.5 Cores (non-levallois and non-blade)

Following the approach of Shaw (2012) non-Levallois and non-blade cores have been put into groups based on reduction method (e.g. migrating platform, discoidal etc.), to allow for analysis into questions of technological choices e.g. whether reduction intensity or raw material size can explain the features now visible on the cores. Further, individual core reduction has been tracked through the recording of core episodes and total number of flake removals. Following Ashton and McNabb (1996) the reduction sequence of a given non-Levallois and non-blade core is recognized as having been divided into a series of separate stages called core episodes. A core episode is identified as a single run of flake detachments from one platform and is also sometimes called *knapping episodes*, *flaking episodes*, or a *run of detachments* (McNabb 2007: 319-324).

4.5.1 Quantitative variables

Maximum dimension: One measurement along the surface with greatest diameter (mm).

Weight (grams): Weight was recorded using digital scales rounded up or down to the nearest gram.

Total number of core episodes: total number of single run of flake detachments from one platform.

Total number of removals: This only includes scars with a minimum dimension of 5 mm.

4.5.2 Qualitative variables

Characterisation of overall core-reduction method:

1) Migrating platform. Overall expedient or *ad hoc* exploitation of multiple platforms, not conforming to any particular template or pattern. The most convenient platform relative to desired end product is exploited as the core's morphology changes throughout the reduction sequence.
2) Single platform unprepared. Cores are worked from a single unprepared platform.
3) Bipolar unprepared. Cores are worked from two opposed, but unprepared platforms.
4) Discoidal. Cores are knapped using alternate/alternating flaking. The discoidal method differs from the Levallois method in having a non-hierarchical configuration of its two surfaces. The peripheral platform is unchangeable; however within a single operational sequence, in contrast to the Levallois method, the roles of the two faces can be reversed (Boëda 1995: 61-63).
5) Indeterminate

Blank type: Determining from which kind of blank a core was produced allows inferences to be drawn regarding the availability and preference of raw material. Blank type is recognized through distribution of cortex and/or natural fracture surface, and/or relict ventral/dorsal.

1) Nodule
2) Flake
3) Thermal/frost flake

4) Shattered nodule
5) Indeterminate

Cortex on surface area of core: Recording of the extent of cortex or any natural surface residual on the surface of a core. This is measured as percentage divisions falling within 6 categories.

1) 0%
2) >0-25%
3) >25-50%
4) ca. 50%
5) >50-75%
6) >75%

Blank form retained: If a core preserves enough cortex/natural surface or can be said to retain the overall form of its original morphology (e.g. large flake), it will be possible to determine its original blank form. This is interesting in relation to reduction intensity and will disclose information regarding raw material economy.

1) Yes
2) No

Number of flake removals per core episode: Using a modified version (Shaw 2012) of a methodology originally constructed by Ashton and McNabb (1996), each flake scar is classified according to one of four possible types (Table 2 and Figure 22)

A	Single removal	Scar resulting from the removal of a single flake from a natural platform, or scars resulting from a previous, unrelated core episode.
B	Parallel flaking	Two or more flakes removed in the same direction from the same or adjacent platforms.
C	Alternate flaking	The proximal end of one or more previous flake scars was used as the platform for the removal of a further sequence of one or more flakes.
D	Unattributed	A flake scar which can be recognised but not attributed to a particular sequence.

Table 2 - Types of core episodes

(After Ashton and McNabb 1996)

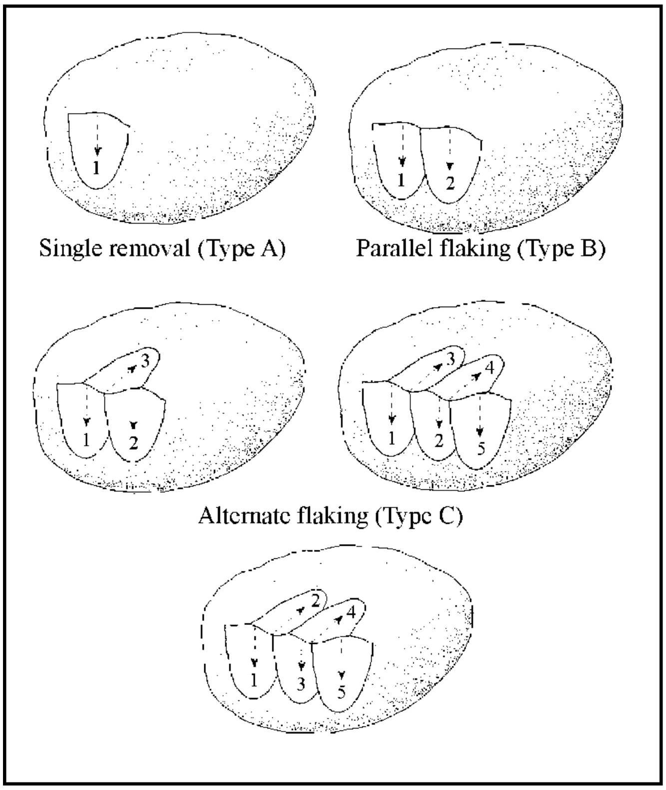

Figure 22 - Types of core episodes (After Ashton 1998)

Retouch: Is the artefact retouched or not. If it is, the specific kind and amount of retouch is described in the retouched artefacts section (see below).

1) Yes
2) No

4.6 Levallois cores and simple prepared cores

4.6.1. Core characteristics

This study follows established classification for the recognition and recording of Levallois artefacts (Boëda 1986, 1995; Scott 2011) which entails adhering to a six point volumetric identifying system (*Table 3 - The six technological criteria defined by Boëda (1986, 1995) for identifying the Levallois method*). If a core matches all six criteria it can be labelled as a Levallois core. A core which exhibits the criteria of distal and lateral convexities on its flaking surface but lacks a consumptive Levallois removal – in which case criteria 4 and 5 regarding determination of fracture plane and axis of predetermined blank becomes impossible – will be treated as an unstruck Levallois core (cf. Van Peer 1992). If a core has exploited the natural convexities of a nodule and therefore does not preserve evidence which can verify the distinct surface flaking configuration necessary for a full classification as true Levallois (criterion 3), but otherwise satisfy criterion 1-2, and 4-6, it can be termed a simple prepared core (cf. Kuhn 1995; White and Ashton 2003; Bolton 2015).

1	The volume of the core comprises two surfaces separated by a plane of intersection.
2	The two surfaces are hierarchically related and non-interchangeable; one acts as a flaking surface and the other as a striking platform surface.
3	The configuration of the flaking surface predetermines the morphology of the products through the management of the distal and lateral convexities (see Figure 23).
4	The fracture plane for the removal of predetermined blanks is parallel to the plane of intersection between the two surfaces.
5	The point at which the striking platform surface and flaking surface intersect is perpendicular to the flaking axis of the predetermined flakes.
6	Hard hammer percussion is employed.

Table 3 - The six technological criteria defined by Boëda (1986, 1995) for identifying the Levallois method (After Scott 2011).

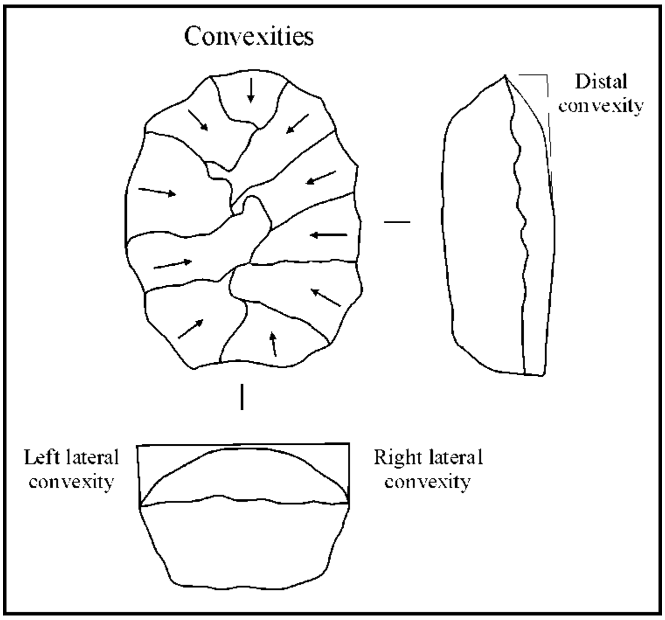

Figure 23 - Illustration of the distal and lateral convexities necessary to allow successful exploitation of a Levallois flaking surface (After Scott 2011).

4.6.2 Quantitative variables

Length (mm) Length is measured according to the axis of detachment of the Levallois end product. If a core is "unstruck", or if the core has been exploited through the centripetal recurrent method, the core should be measured in relation to the distal and lateral convexities (Shaw 2012)

Width (mm): Refers to the maximum width at 90° to the axis along which the length was measured.

Maximum thickness (mm): Measured between the two most distant points on the striking platform surface and flaking surface (flake release surface), perpendicular to the plane of intersection.

Weight (grams): Weight was rounded up or down to the nearest gram.

Number of flaking surface scars: number of preparatory scars visible on the flaking surface with a minimum dimension of at least 5 mm.

Number of striking platforms scars: number of striking platform scars visible on the striking platform surface with a minimum dimension of at least 5 mm.

Number of definite Levallois products: total detached from the final flaking surface.

Dimensions of final Levallois products:

1) Length (mm)
2) Width (mm)

Indices: The utilization of the concepts of "elongation" and "flattening" (see Scott 2011) can reveal different information pertaining to Levallois artefacts. Where elongation is useful for understanding Levallois end products, flattening can reveal to what extend a Levallois core has been exploited proportionate to its inferred original size. By using quantitative variables of width, length, and thickness, the flatness and elongation of cores and the elongation of end products, like flakes or points, within an assemblage, can be used to demonstrate degree of raw material exploitation and management, and through this appreciate notions of expediency and curation within hominin *chaîne opératoire*.

1) Elongation (Width divided by Length)
2) Flattening (Thickness divided by Width)

4.5.3 Qualitative variables

Core type:

1) Levallois
2) Simple prepared

Blank type (see above):

1) Nodule
2) Flake
3) Thermal/frost flake
4) Shattered nodule
5) Indeterminate

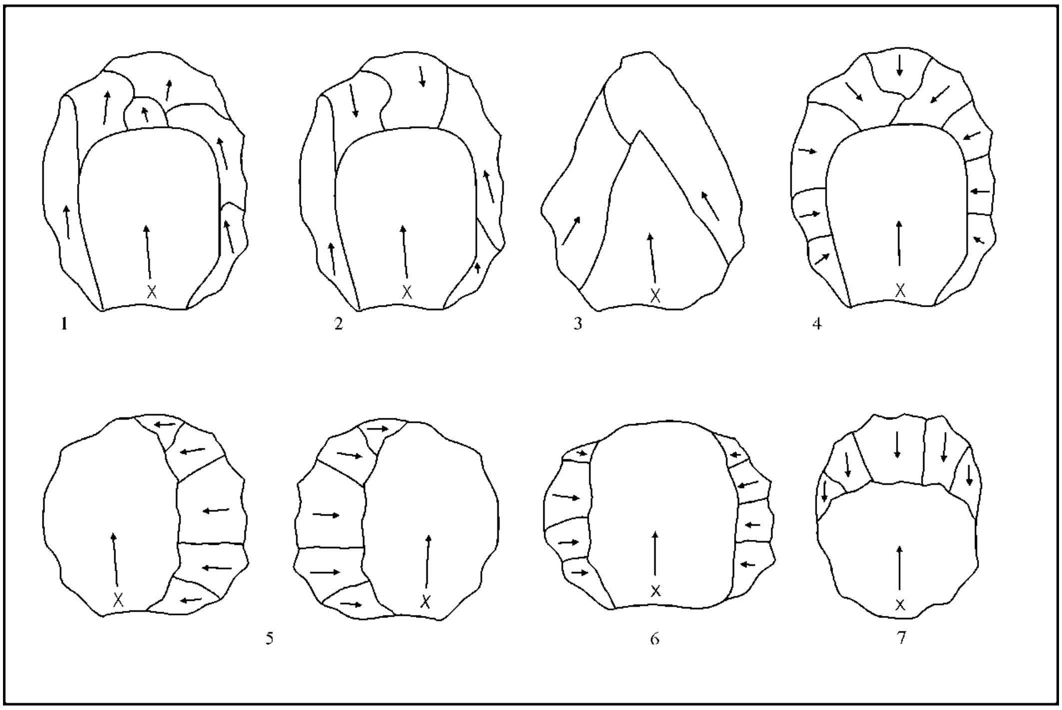

Figure 24 - Methods of Levallois core preparation based upon the location of preparatory flake scars (X=direction of Levallois removal): 1=unipolar, 2=bipolar, 3=convergent unipolar, 4=centripetal, 5=unidirectional lateral, 6=bipolar lateral, 7=unipolar distal (after Boëda 1986; 1995, redrawn by Scott 2011).

Method of preparation of final flaking surface (after Boëda 1986, 1995): This is identified by distinguishing the orientation of the flake scars which have been detached before any invasive, volumetrically consumptive removal recognized as being a Levallois end product (Figure 25, Scott 2011). The core should be oriented along the main axis of Levallois flaking. If the core is unexploited it should be oriented according to the distal and lateral convexities. In the case that repreparation can be identified all earlier scars must be considered (Scott

2011). It is generally accepted (cf. Dibble 1995b; Meignen 1995; Jaubert and Farizy 1995; Texier and Francisco-Ortega 1995; Bar-Yosef and Van Peer 2009; Lycett and Eren 2013) that the techniques responsible for the surface preparation of a Levallois core were not rigid or monotonous but most likely changed throughout the reduction sequence. However, only the final sequence of preparation and exploitation can now be recovered (Scott 2011; cf. Van Peer 1992).

1) Unipolar
2) Bipolar
3) Convergent unipolar
4) Centripetal
5) Unidirectional lateral. Identified if preparatory flake scars have been detached from the right lateral, or from the left. Such flake scar configuration could also be evidence for either centripetal preparation or shifting of striking platform after unipolar preparation or unipolar recurrent exploitation. However, if one of these three latter configurations cannot be proven unambiguously, the preparation is recorded as unidirectional lateral (Scott 2011).
6) Bipolar lateral
7) Unipolar from distal
8) Indeterminate i.e. it is a core fragment, or the flaking surface is obscured.

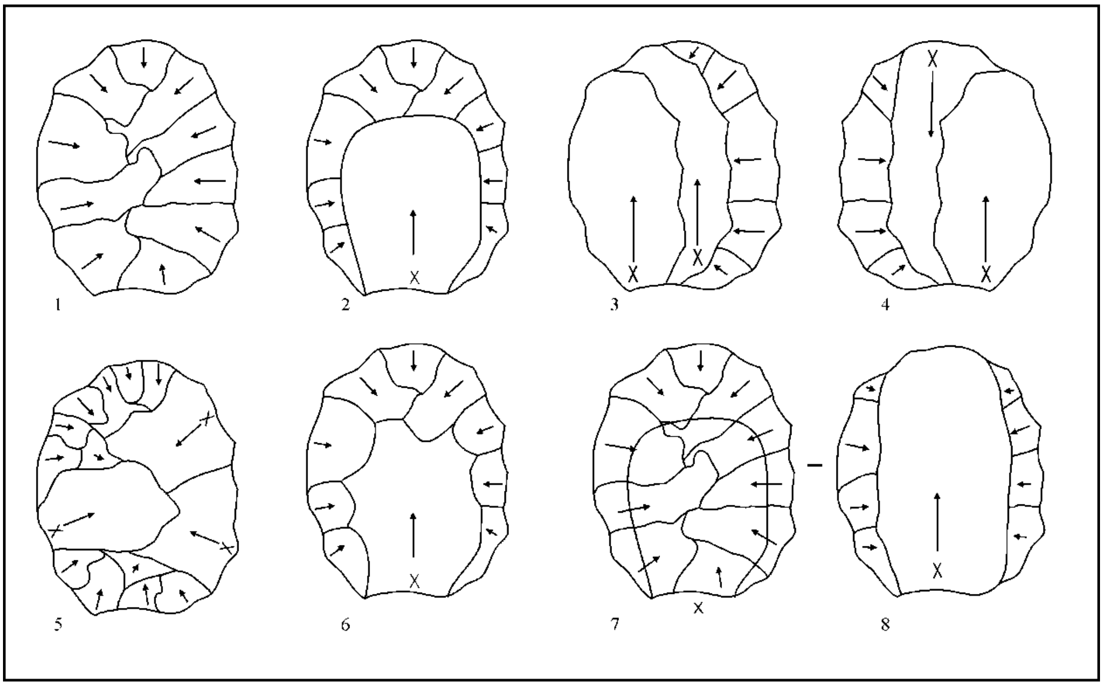

Figure 25 - Method of exploitation of final Levallois flaking surface (X=direction of Levallois removal): 1=unexploited, 2=lineal, 3=unipolar recurrent, 4=bipolar recurrent, 5=centripetal recurrent, 6=re-prepared but unexploited, 7=failed; undetached, 8=failed; overshot (after Boëda 1986; 1995, redrawn by Scott 2011).

Method of exploitation of final flaking surface (after Boëda 1986, 1995): Identified by distinguishing the orientation of one or more invasive, volumetrically consumptive flake scars interpreted as being Levallois removals (Figure 25).

1) Unexploited. If the core has been prepared according to the concept outlined above, but has no evidence for volumetrically consumptive flaking associated with Levallois exploitation, the core is recorded as unexploited.
2) Lineal. One Levallois product only has been detached from the flaking surface. No evidence of an earlier, preceding Levallois product from the same flaking surface can be discerned.
3) Unipolar recurrent. Using only one striking platform, two or more Levallois products have been detached from the same flaking surface.
4) Bipolar recurrent. Using opposed striking platforms, two or more Levallois products have been detached from the same flaking surface.

5) Centripetal recurrent. Using various platforms around the periphery, two or more Levallois products have been detached from the same flaking surface.
6) Re-prepared but unexploited. Contrary to an unexploited Levallois core, the surface of a re-prepared but unexploited core has definitely been re-prepared following volumetrically, consumptive Levallois removal(s). However, for whichever reason, no exploitation has preceded the repreparation.
7) Failed final removal. A single Levallois detachment has failed to separate from the core, or have overshot the core edge.
8) Indeterminate. Either a whole core or a fragment whose flaking surface is obscured (e.g. by damage)

Evidence of an earlier flaking surface: A core can show signs of having been deliberately re-prepared following an earlier detachment of a Levallois product. This is the common interpretation if a large, consumptive flake scar is cut by smaller scars around its periphery. Such a feature is argued to be evidence of an earlier flaking surface (Scott 2011). The final flaking surface may or may not have been exploited as illustrated in drawing 6 in Figure 25.

1) Yes
2) No

Morphological description of Levallois products from final flaking surface:

1) Unexploited
2) Flake
3) Point
4) Blade
5) Debordant flake - has removed one or both lateral core edges
6) Overshot distal end
7) Debordant and overshot
8) Failed removal(s)

9) Indeterminate

Recording of the extent of cortex or any natural surface residual on the striking platform surface of a core: This is measured as percentage divisions falling within 6 categories. By measuring extent of cortex retention, it is possible to discuss evidence for original size of raw material and reduction intensity.

1) 0%
2) >0-25%
3) >25-50%
4) ca. 50%
5) >50-75%
6) >75%

Position of cortex on striking platform surface: Recording the position of cortex of the striking platform surface further helps elucidate what size or shape of raw material was exploited. For example, the pattern of knapped (scar) and un-knapped (cortex) area left on the striking platform surface, can hint of how and how much, a core has been prepared, relative to its size.

1) None
2) One edge only
3) More than one edge
4) Central
5) Central and one edge
6) Central and more than one edge

Remnant distal ends of large scars on striking platform: The recording of remnant distal ends of large flake scars on the striking platform will help determine to what extent a Levallois core can be said to have been exploited (Shaw 2012). If cortex retention does not provide sufficient information about original dimension of the core, the identification of large remnant distal ends can provide additional evidence for the degree of exhaustion caused by reduction:

1) Yes
2) No

Retouch (additional observations in retouched artefacts section below):

1) Yes
2) No

4.7 Levallois products

4.7.1 Levallois product characteristics

Levallois products are identified using a combination of indicative features (Boëda 1986, 1995; van Peer 1992; Scott 2011) which serves to acknowledge that such flakes have been detached from the flaking surface of a Levallois core. Features considered being indicative of Levallois products:

1) Are struck using a hard hammer.
2) Display a relatively large number of dorsal scars, and potentially a complex dorsal scar pattern.
3) Are removed from a surface, rather than biting into the volume of a core, and are therefore relatively flat in longitudinal section.
4) Exhibit the distal and lateral convexities which controlled detachment along the flaking axis, reflecting the fact that such flakes preferentially consume the flaking surface of the Levallois core.
5) May retain evidence of deliberate platform preparation, such as faceting.
6) May also retain evidence of deliberate convexity accentuation, in the form of relatively small peripheral flake scars.

4.7.2 Quantitative variables

Length (mm): Measured along the axis of percussion.

Width (mm): Refers to the maximum width at 90° to the axis of percussion.

Maximum thickness (mm): Measured between the two most distant points on the dorsal and ventral surfaces perpendicular to the plane defined by the dorsal and ventral surfaces.

Number of dorsal scars: total number with a minimum dimension of at least 5 mm.

Levallois removals: total number of preceding Levallois removals.

Index of elongation: The recording of the elongation of Levallois products has the potential to show if such figures match those recorded from Levallois cores. The degree of congruence will be central in an estimation of stages of *chaîne opératoire* at a given site. The figures are generated using a model of quantitative variables taken from Scott (2011).

1) Elongation (width divided by length)

4.7.3 Qualitative variables

Dorsal cortex on Levallois product:

1) 0%
2) 1-25%
3) 26-49%
4) ca. 50%
5) 51-75%
6) 76-99%
7) 100%

Portion of flake: (see above)

1) Whole

2) Proximal
3) Distal
4) Mesial
5) Siret

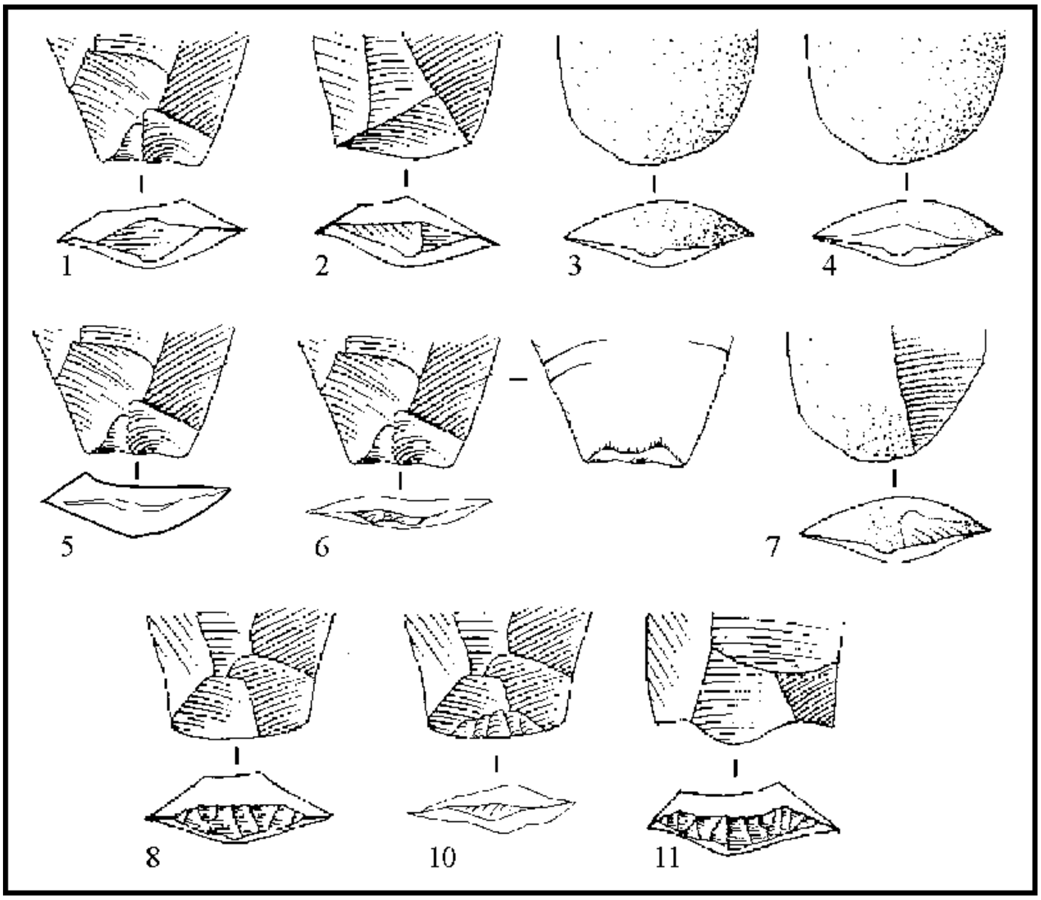

Figure 26 - Flake butt types. Numbers follow Inizan et al. (1999) except for Chapeau de Gendarme which here is no. 13.

Butt type: Same as for non-Levallois flakes; however, a further type, "Chapeau de Gendarme" is included. Chapeau de Gendarme is "[a]*n expression applied specifically to a form of facetted butt*" (Inizan et al. 1992: 82) (Figure 26), and while not exclusive to Levallois production this type of preparation of a preferential striking platform is however quite common (Inizan et al. 1992: 53).

1) Plain
2) Dihedral
3) Cortical

4) Natural
5) Marginal
6) Soft hammer
7) Mixed
8) Facetted
9) Missing
10) Trimmed
11) Obscured
12) Retouched
13) Chapeau de Gendarme

Type of Levallois product in morphological terms: Important in respect of understanding overall assemblage composition and preferences in reduction and technological variability.

1) Flake
2) Point
3) Blade
4) Debordant flake (lateral edge of core removed)
5) Overshot
6) Debordant and overshot
7) Indeterminate (partial end-product which cannot be classified)

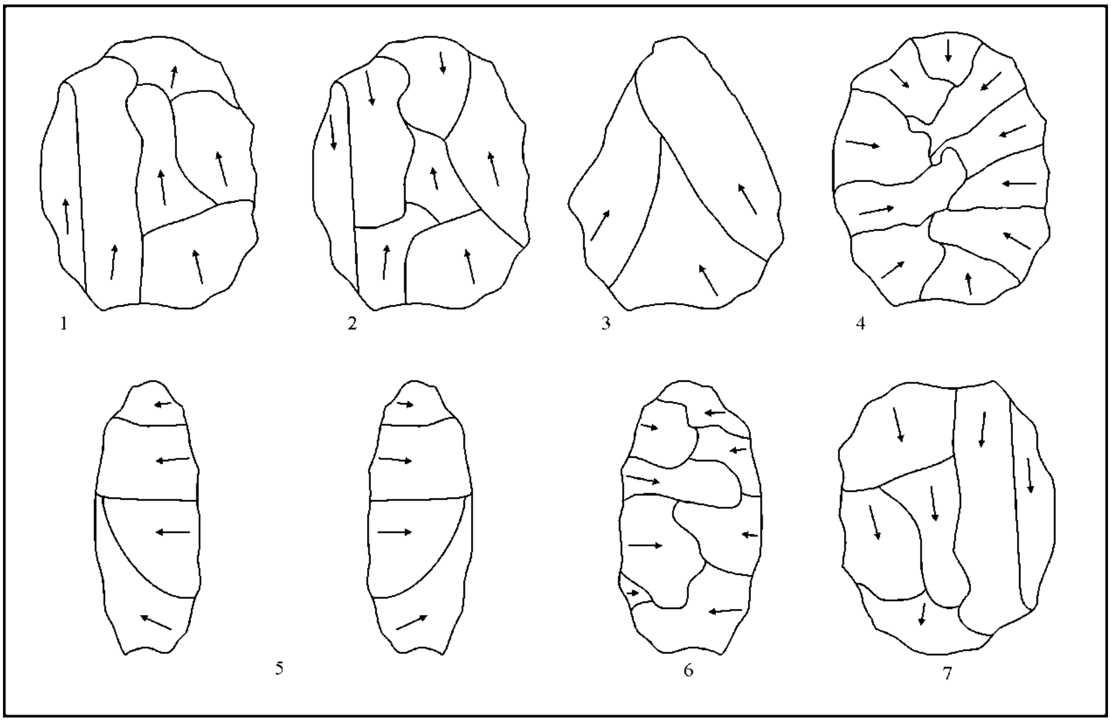

Table 4 - Method of preparation inferred from Levallois flakes, based upon orientation of non-Levallois flake scars: 1=unipolar, 2=bipolar, 3=convergent unipolar, 4=centripetal, 5 = lateral, 6=bipolar lateral, 7=unipolar distal (after Scott 2011).

Method of preparation (after Boëda 1986, 1995 and Scott 2011) (Table 4): The way to identify the method by which a Levallois product has been prepared is through the orientation of its preparatory flake scars, both non-Levallois and Levallois. A previous Levallois flake scar is viewed as being predetermining as well as predetermined (Boëda: 1995: 56)

1) Unipolar
2) Bipolar
3) Convergent unipolar
4) Centripetal
5) Unidirectional lateral. Preparatory scars are detached from one edge only. Such scars might indicate a shift in position of striking platform following either unipolar preparation or unipolar recurrent exploitation. It might also point to centripetal preparation where the detachment of the Levallois end product from the flaking surface happened early. In such instance the distal preparatory scars will not have

been detached with the flake, but left on the core (Scott 2011: 221). However, if one of these three latter configurations cannot be proven explicitly, preparation is recorded as unidirectional lateral.

6) Bipolar lateral. Preparatory scars are detached from both lateral edges. Such scaring might indicate a shift in position of striking platform following bipolar preparation or bipolar recurrent exploitation. It might also point to centripetal preparation in a case where the flake detached before reaching the distal end of the core (Scott 2011, see above).
7) Unipolar from distal.
8) Indeterminate (fragmentary, or obscured flaking surface).

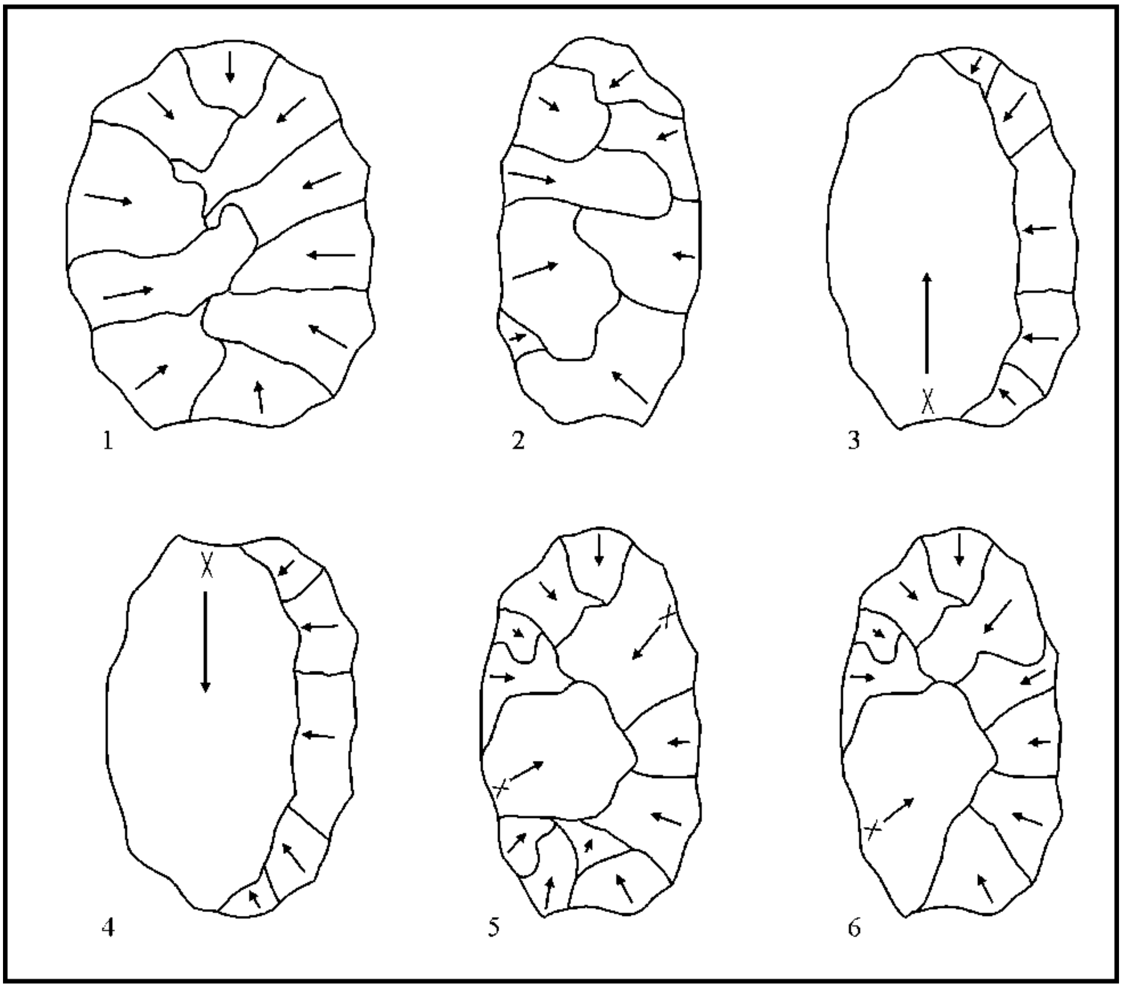

Figure 27 - Illustration of scar patterns indicative of exploitation method on Levallois flakes 1=lineal (up to core edges; clearly preventing removal of subsequent flake), 2=single removal, 3=unipolar recurrent, 4=bipolar recurrent, 5=centripetal recurrent, 6=indeterminate. (X=direction of preceding Levallois flake scar) (after Scott 2011).

Method of exploitation (after Boëda 1986, 1995 and Scott 2011; (Figure 27) The method of exploitation by which to assign a Levallois flake depends on two features: the orientation of any previous Levallois flake scars visible on the flakes dorsal surface, and whether or not the flake can be demonstrated to have been preceded by another Levallois product from the same flaking surface. The following categories were recognised (Scott 2011: 220):

1) Lineal. A lineal Levallois product does not preserve evidence of preceding Levallois product scars and can itself not be preceded by another Levallois product as its circumference clearly consumes entirely the volume of the flaking surface. Consequently, a repreparation in required in order to detached a new Levallois product.
2) Single removal. While not preserving evidence of preceding Levallois product scars, the circumference of a single removal does not preclude the possibility of another Levallois product being subsequently detached from the same flaking surface. This way it cannot be claimed to be a lineal exploitation.
3) Unipolar recurrent. One or more preceding Levallois products have been detached using the same flaking axis as the product itself.
4) Bipolar recurrent. One or more preceding Levallois products have been detached using an opposed, or same direction and opposed, axis of flaking as the product itself.
5) Centripetal recurrent. One or more preceding Levallois products have been detached using a variety of axis different from the product itself.
6) Indeterminate. If the scar from an earlier Levallois product exploitation phase is unclear the method of exploitation is stated as indeterminate. This is exemplified by illustration 6 in Figure 27 where a preceding product scar can be interpreted either as pertaining to centripetal recurrent or unipolar recurrent exploitation (Scott 2011).

Evidence of repreparation of the flaking surface preceding the removal of the last Levallois flake: Indicated by an invasive Levallois removal clearly being cut by smaller, less invasive, later scars:

1) Yes
2) No

Retouch:

1) Yes (additional observations in retouched artefacts section below)
2) No

4.8 Retouched pieces

The methodology used in this thesis follows the terminology by Inizan et al. (1999) regarding the nature and distribution of retouch. Every modified piece was systematically examined to identify any patterning potentially present in the assemblage. Typological classifications are offered were applicable.

4.8.1 Quantitative variables

Length of margins: The length in mm. of the circumference of the flake measured on the ventral margins.

RA length: Measure in mm. of the length of retouched areas. Unretouched areas, within a defined discontinued area of retouch, are not included.

4.8.2 Qualitative variables

Number of areas of retouch (RA) / events of retouch: Separate retouch events on a flake are recorded as separate retouch areas (RA). Each RA will be treated separately. This procedure is followed to identify potential multi-tools or evidence for recycling/reuse.

Retouch area order: If possible, the order of separate retouch events is recorded.

RA fresh on patinated: Evidence of unpatinated retouch on patinated flake scar.

Retouch technique (position of retouch) (Figure 28**)**

Direct: Retouch is located on the dorsal face, or the surface with the greatest volume above the secant plane.

1) Inverse: Retouch is located on the ventral face, or the surface with the least volume below the secant plane.
2) Bifacial: Retouch is located on both faces on the same edge.
3) Alternating
4) Alternate: Retouch is located on the same side of the flake regardless of which side is facing up, e.g. left lateral dorsal and right lateral ventral.
5) Crossed: Retouch is directed into both faces to form a steep backed edge.
6) Burination: One or more burin blows have removed the flake margins (proximal, distal, left and/or right), removing part of the ventral and dorsal surfaces.

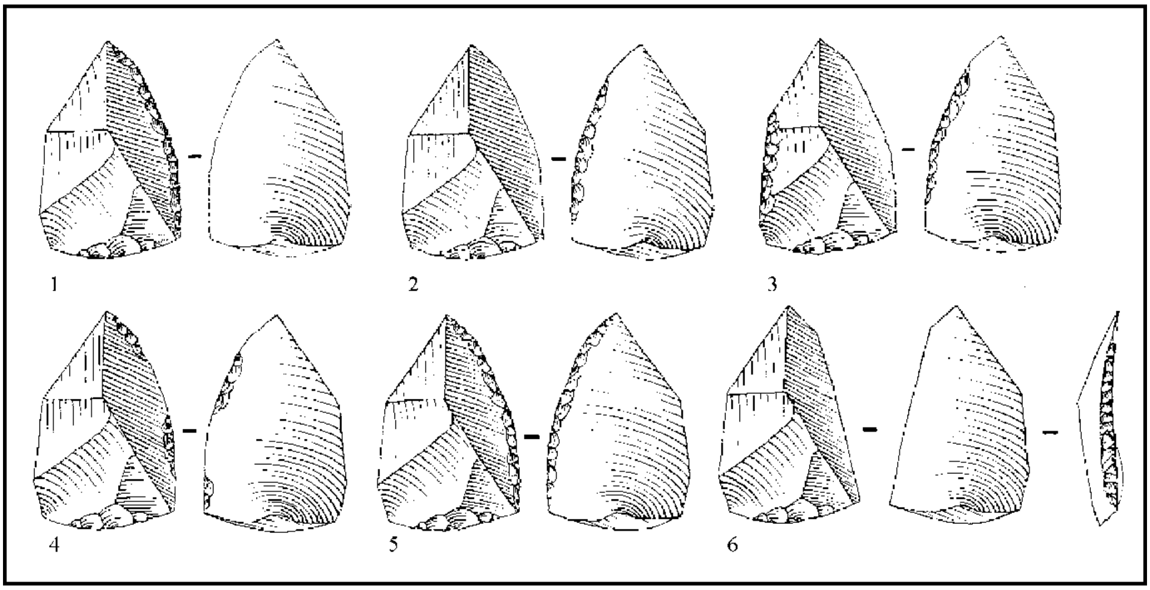

Figure 28 - Position of retouch on flake tools 1=direct, 2=inverse, 3=alternate, 4 and 5 = bifacial, 6=crossed (reproduced from Inizan et al. 1999).

Retouched platform:

1) Yes
2) No

Thinning: Possible indication of deliberate modification of a flake for hafting purposes.

1) Yes
2) No

RA location

1) Proximal/butt
2) Left lateral edge
3) Right lateral edge
4) Both lateral edges
5) Continuous except proximal/butt
6) Continuous except other portion
7) Distal/tip

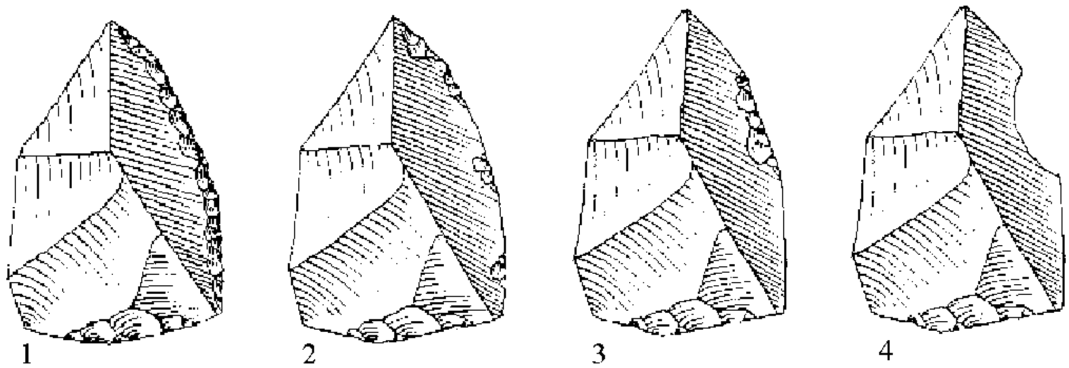

Figure 29 - Distribution of retouch on flake tools 1=continuous, 2=discontinuous, 3=partial, 4= isolated removal (modified from Inizan et al. 1999).

Distribution of retouch (Figure 29**)**

1) Continuous
2) Discontinuous
3) Partial

4) Isolated removal

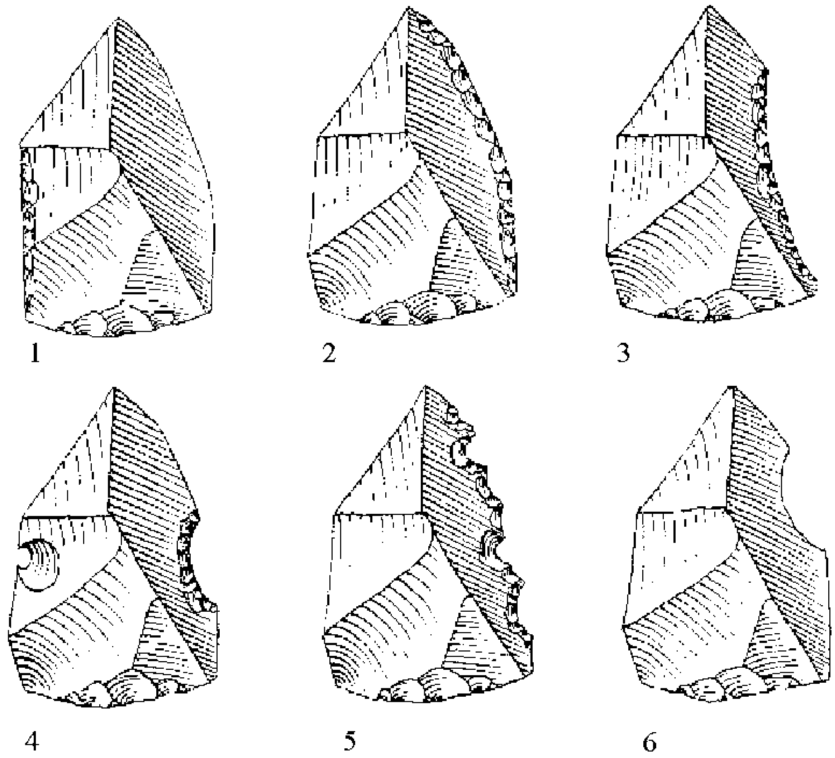

Figure 30 - Form of retouched edges on flake tools 1=rectilinear, 2=convex, 3=concave, 4=retouched notched, 5=denticulated, 6=flaked flake (modified from Inizan et al. 1999).

RA shape (form of retouched edge): (Figure 30**)**

1) Straight edge (rectilinear)
2) Convex
3) Concave
4) Simple notch
5) Complex notch
6) Denticulated
7) Shouldered
8) Tanged
9) Pointed
10) Perforator
11) Nosed

12) Burin

13) Truncated/faceted

RA invasiveness (extent of retouch):

1) Marginal
2) Invasive
3) Total coverage

RA backing form (angle of retouch):

1) Abrupt (approaching 90°)
2) Semi-abrupt (~45°)
3) Low (thinning)

Regularity of retouched edge:

1) Regular
2) Irregular
3) Single removal
4) Obscured by damage that cuts across the retouch

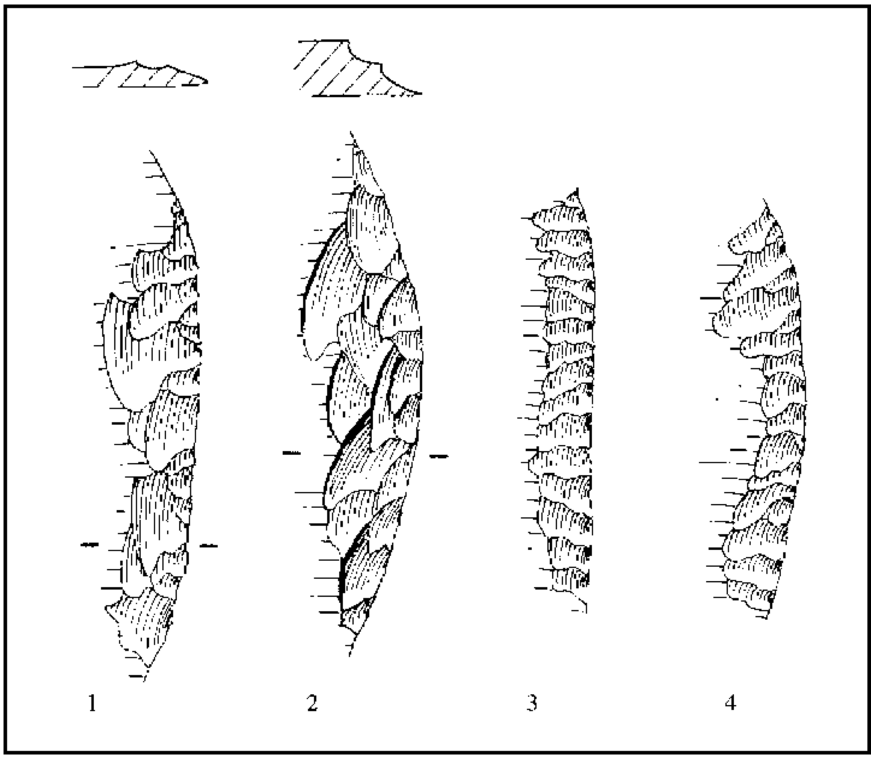

Figure 31 - Morphology of retouch on flake tools
1=scaly, 2=stepped, 3=parallel, 4=sub-parallel (modified from Inizan et al. 1999).

RA retouch type (morphology of retouch) (Figure 31**):**

1) Scaly
2) Stepped
3) Sub-Parallel
4) Parallel
5) Single removal
6) Burination

Three defined varieties of core-on-flakes: Three variations of core-on-flakes were identified for this methodology (Table 5).

CoreOnFlakeVen: Core-on-flake, struck from ventral
CoreOnFlakeDors: Core-on-flake, struck from dorsal
CoreOnFlakeBoth: Core-on-flake, struck from both ventral and dorsal

Table 5 - Three defined varieties of core-on-flakes

Truncated facetted pieces: 15 defined constellations of truncated-facetted pieces (Table 6)

Flake tools: Description of flake tools will be offered according to conventional typology (Bordes 1961; Debénath and Dibble 1994) where applicable or through technological characteristics if functional association is disputed or unknown.

TFpProx	Truncated-facetted piece, proximal
TFpDist	Truncated-facetted piece, distal
TFpProxDist	Truncated-facetted piece, proximal and distal
TFpRightlat	Truncated-facetted piece, right lateral
TFpLeftlat	Truncated-facetted piece, left lateral
TFpRightLeftlat	Truncated-facetted piece, right and left lateral
TFpPRlat	Truncated-facetted piece, proximal and right lateral
TFpPLlat	Truncated-facetted piece, proximal and left lateral
TFpPRLlat	Truncated-facetted piece, proximal, right and left lateral
TFpDRlat	Truncated-facetted piece, distal and right lateral
TFpDLlat	Truncated-facetted piece, distal and left lateral
TFpDRLlat	Truncated-facetted piece, distal, right and left lateral
TFpPDRlat	Truncated-facetted piece, proximal, distal and right lateral
TFpPDLlat	Truncated-facetted piece, proximal, distal and left lateral
TFpPDRLlat	Truncated-facetted piece, proximal, distal, right and left lateral

Table 6 - defined constellations of truncated-facetted pieces

4.9 Summary

This chapter has dealt with methodological issues relevant to the collection of data through attribute analysis. It was decided to use a methodology rooted in the interpretation of surface material, as 'older' collections tend to lack resolution in debitage, and also can have issues with stratigraphic and taphonomic integrity, making them inadequate for more detailed queries. For these older collections, issues of taphonomy for the evaluation of intra-assemblage integrity is important. More specifically relating to the question of association of the sample assemblages with the Zagros Mousterian, the following points were included in the attribute analysis: information on raw material and raw material sources, as the techno-behavioural foundations of the techno-complex point to features in the reduction sequence which would serve to indicate a lack of local raw material sources at the high altitude sites. As the size of flakes in the Zagros Mousterian have been noted to be relatively short compared to Levantine Mousterian, quantitative and qualitative variables are included to gather information on size and features of reduction. Further looking into recording reduction sequences, the indication of uni- and bi-directional knapping patterns at lower altitudes, and more centripetal modes of reduction at higher altitudes, made it pertinent to include variables indices such as dorsal scar pattern and cortex retention. Specifically, the 14-tiered classification scheme for recording dorsal scar pattern, were purposely designed for this methodology. Flake typology and retouch intensity were especially elaborated on, as these features too are areas of comparison between the Zagros and the Levantine Mousterian. Differences between non-Levallois and Levallois core flaking were specified and elaborated on, as Levallois, at least previously, were thought to be rare in the Zagros, but now are invoked to gauge techno-behavioural characteristics, such as landscape-use and raw material curation.

Chapter 5 - Houmian data analysis

5.1 Excavation

The site of Houmian had already been visited by treasure hunters, presumably looking for so-called "Luristan Bronzes", for which the province is renowned. These efforts had left what in the technical literature is known as *robber holes* or -pits, which in this case for the scientific work came to serve as convenient guides to the rock shelter's stratigraphy.

The excavation consisted of 7 *cuts*, also referred to as *trenches*, recorded as cuts A, A2, A3, B, C, C2, and D (Figure 32 - Figure 35). These were set amongst the robber holes, and dug in *spits*. A spit would vary in size from 15-25 cm thickness and consisted of various *batches*, a batch being the basic unit of recovery, "*a number of batches making up a spit*" (Bewley 1984:14). An estimated 25 square meters were opened up, considered to amount to one quarter of the site total (Bewley 1979: 13). According to Bewley's later assessment (1984: 12) 5-10 cubic meter of deposit was taken out over the course of that week, exposing 10 layers, totalling "*at least 3 meter of depth*" (McBurney 1970: 186).

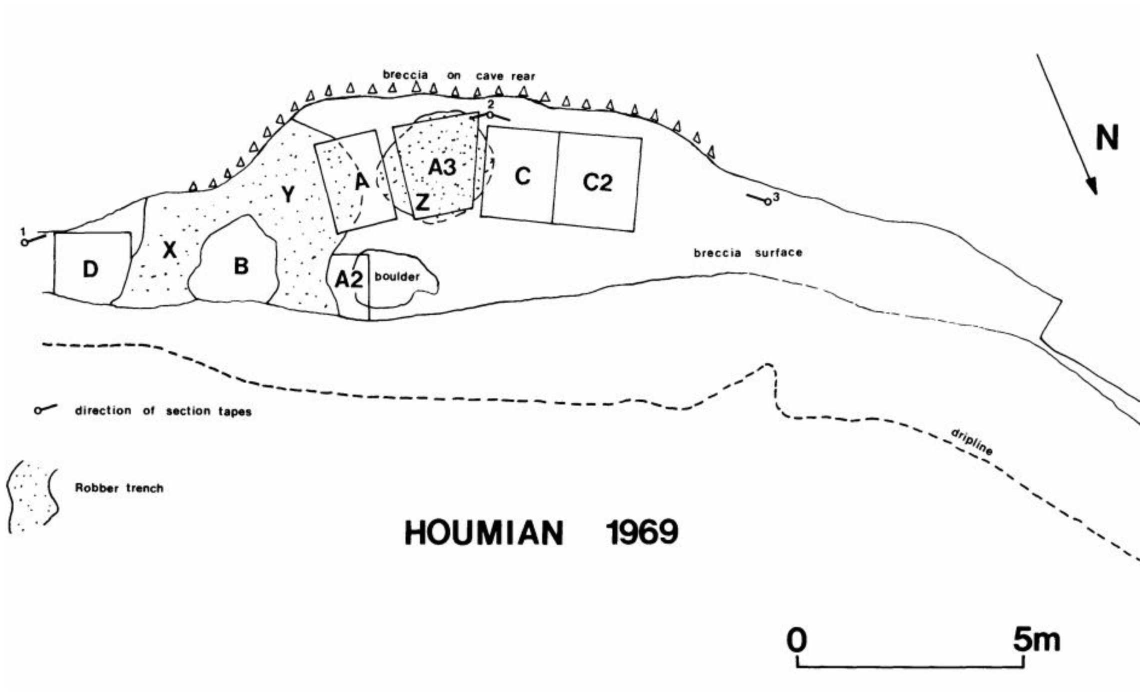

Figure 32 - Plan of trench at Houmian (after Bewley 1984).

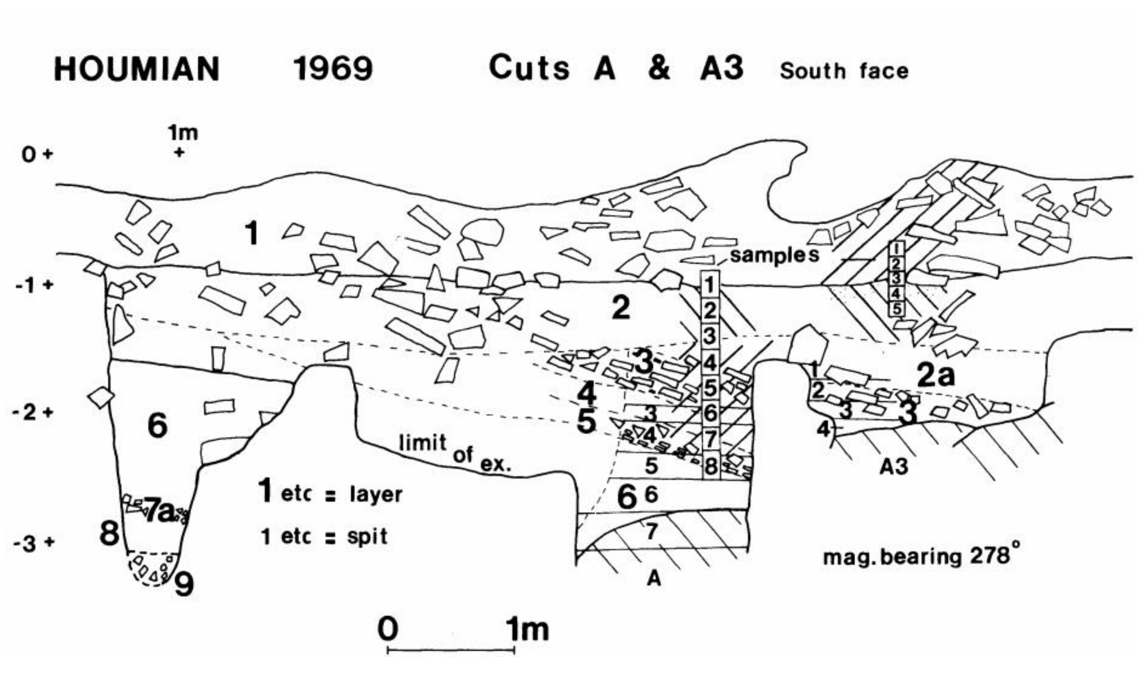

Figure 33 - Sections of Cuts A and A3, south face, Houmian (after Bewley 1984).

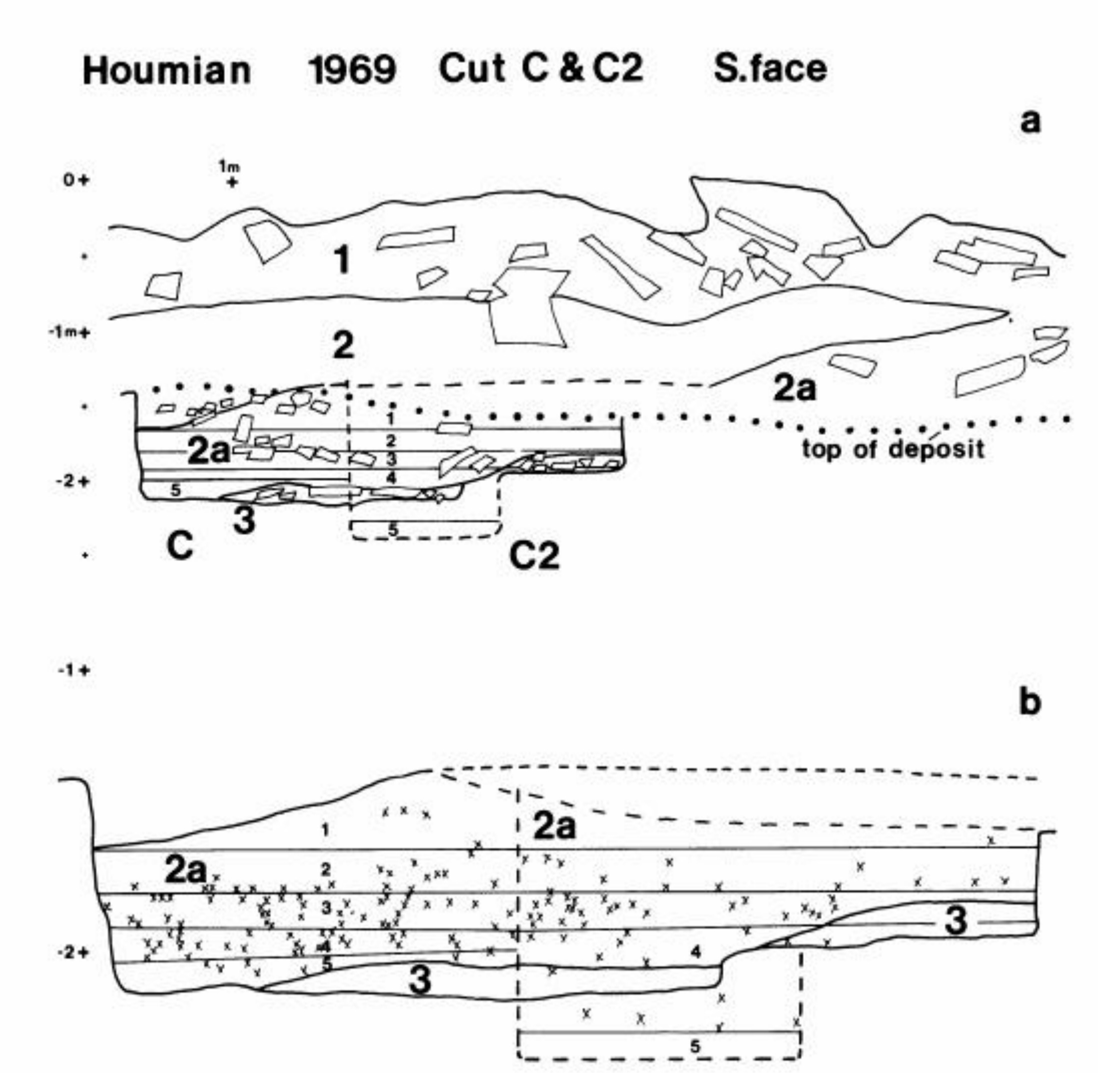

Figure 34 - A Section of Cuts C and C2, south face, Houmian; B - Three-dimensionally recorded artefacts from Cut C2, Houmian (after Bewley 1984)

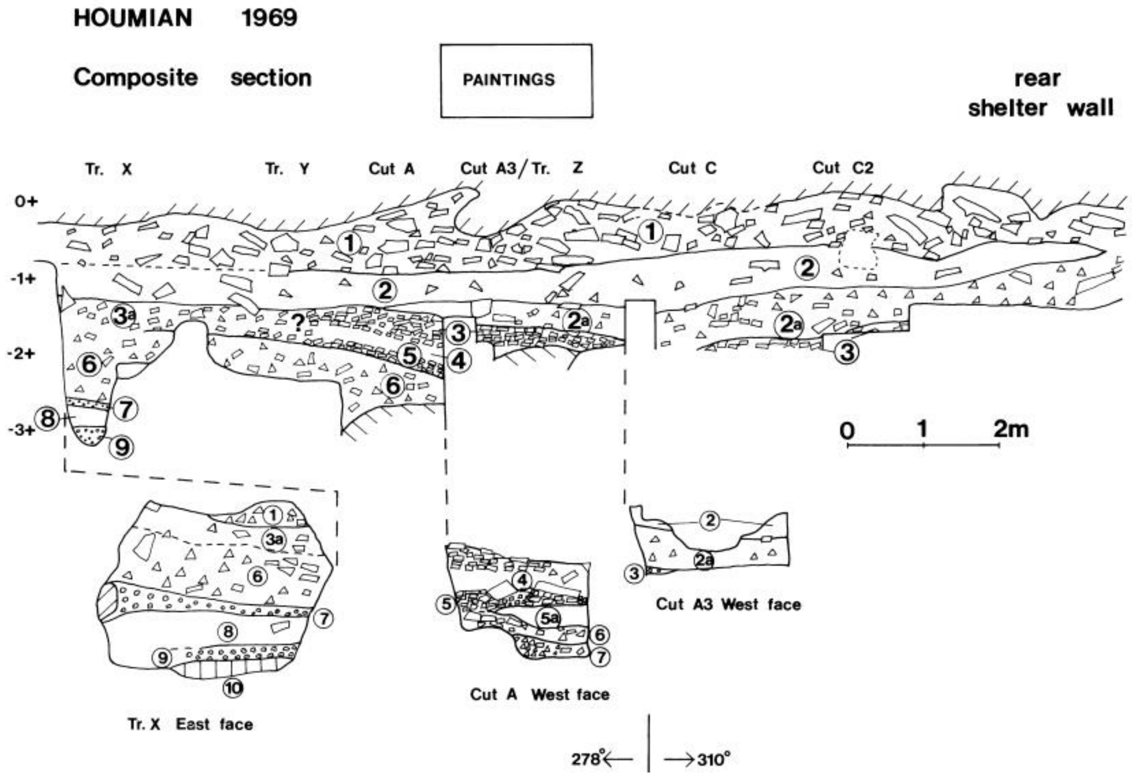

Figure 35 - Composite section, Houmian (after Bewley 1984)

Of these 10 layers, layers 2, 2a, and 3 were the most important in terms of finds and sampling potential. Layer 2a by far has the highest concentration of lithics (more than 50% of the combined lithic material, Bewley 1979: table III), and was exposed in cuts A, A3, C, and C2. Only 22 lithics in total have been identified from cuts A2, B, and D. Because of this small number, material from these three cuts have been excluded from further study in this thesis.

5.2 Curational history

The lithic collection from Houmian is housed at the Museum of Archaeology and Anthropology at the University of Cambridge.

5.3 Sampling method

Description of Middle Palaeolithic lithic assemblages from the Zagros excavated around the middle of the twentieth century usually only survives in a mostly tool and core format. Frequently, only retouched flakes/tools and cores were curated and made it into surviving museum collections. This is due to the practices of the day, where typological studies took precedence due to different research questions. Lithic "debris", i.e. waste flakes, chips, chunks, was considered essentially useless in explaining past behaviour, and was not uncommonly summarily discarded on site. McBurney, at least in this 1969 endeavour, however, does appear to have taken measures to collect "everything", employing a 1 cm mesh size sieve and seemingly curating the total accumulation of the Houmian lithic assemblage, as the 887 pieces includes a component of both broken, unretouched flakes and chips. Similarly, Bewley (1979, 1984), mentions nothing about the assemblage being a sample, anywhere in his accounts of the lithics. In fact, even selections of small unworked pebbles were brought back by McBurney, presumably to aid future contextual studies, an approach embraced by other scholars at the time (e.g. Troels-Smith, unpublished, Lis Nymark, pers. comm.). At a time where the hegemony of the Bordes typology, particularly for the Mousterian, prevailed, such actions must be commended.

While lithics were seemingly recorded three-dimensionally (Figure 4.3; Bewley 1984:16, fig. 16b), if only predominantly within Layer 2a (Bewley 1984:23), the metadata information relating these lithics to their geo-reference has since been obscured (Bewley 1984). In addition, the internal integrity of the spits, i.e. the unit of excavation subdividing each layer, as mentioned above, seem to have been compromised either during excavation or subsequently during curation: "*The correlation of spits to layers is not one to one; a large amount of mixing has occurred*" (Bewley 1979:13-14). This, however, either seems to have been resolved by Bewley's 1984 publication of the site, or found to be less problematic than perceived by 1979, as Bewley (1984) never mentions any form of "mixing" in this study but reiterates that "*the excavation notes and Fig. 16b show that the majority of three dimensionally recorded artefacts were from layer 2a*" (Bewley 1984: 23; figure 34). It is the assumption here that mixing of spits (*within* a distinct Houmian layer) not fundamentally obstructs the composition of an individual layer compared to another layer or fundamentally obstructs the possibility for a behavioural signal through its lithic deposits. It does limit the possibilities for inter-spit and intra-layer analyses, but does not prevent an overall analysis of the combined spits *within* a layer. The following analyses of material from Layer 2a is thus not compromised in this regard.

5.4 Assemblage composition of the lithics

The composition of the lithic assemblage from Houmian as reported by Bewley (1979, 1984) shows a core and flake assemblage with 644 flakes, 150 pieces described as chunks/chips, and 37 cores. Additionally, 8 burin spalls, 47 “split pebbles”, and a hammerstone. 887 pieces in total (Bewley 1984: 21). Of these, 200 are from unstratified contexts, 152 of those being flakes (Bewley 1979:31, table III) (see Appendix plates 1-10).

This study includes 420 lithics from stratified contexts within the Houmian assemblage. Of these 394 are flakes and 26 are cores (Table 7). Below, this assemblage will be presented and described. Before doing so, it is important to explain the reasoning behind the selection of the assemblage to be presented. The selection was made to concentrate efforts on Houmian layer 2a, which as mentioned above, and according to people involved with its publication (Bewley 1984), without a doubt is the single most interesting layer, having most of the lithic and faunal material from the site, as well as the potential for chronostratigraphic identification by way of palynology (Leroi-Gourhan in Bewley 1984: 30).

Data class	Frequency	Percent
Core	26	6.2
CoreOnFlake	3	.7
RetouchedFlake	44	10.5
UnretouchedFlake	347	82.6
Total	**420**	**100.0**

Table 7 - Houmian lithics data class

While firstly differentiating between cores and debitage, i.e. flakes *sensu lato*, a further division of the debitage into unretouched and retouched flakes, and a further distinction between retouched debitage utilised either as tools or cores(-on-flakes) will be adopted. Table 7 shows that 94% of the selected Houmian assemblage is debitage, and that cores constitute just 6%. Table 8, Table 9 and Table 10 present an overview of the distribution of the lithics sample by cut, layer, and spit.

	Cut	Frequency	Percent
	A	10	2.4
	C	319	76.0
	C2	91	21.7
	Total	**420**	**100.0**

Table 8 - Houmian lithics by cut

Layer	Frequency	Percent
?	4	1.0
2a	406	96.7
3	2	.5
5	8	1.9
Total	**420**	**100.0**

Table 9 - Houmian lithics by layer

Spit	Frequency	Percent
1	6	1.4
2	100	23.8
3	154	36.7
4	134	31.9
5	26	6.2
Total	**420**	**100.0**

Table 10 - Houmian lithics by spit

5.4.1 Taphonomic assessment

Although part of the methodological approach, a dedicated taphonomic analysis of effects of sediment on artefact edges was not pursued due to regulations of lithics handling at the institution holding the collection, limiting the number of lithics to be handled at any given time to "one bag". This prevented a contextual, visual (macroscopic and microscopic) appreciation of the full assemblage together. For this reason, a taphonomic analysis has not been carried out. The assemblage does however appear, through non-contextual visual, macroscopic appreciation by the naked eye, to be taphonomically homogenous with little edge damage, no edge rounding by abrasion, or having been post-depositionally moved by either anthropogenic or geological processes. At least not to any noticeable degree. If heavy re-deposition through fluvial or alluvial agency had been at work the appearance of the assemblage would be expected to show more obvious signs (see Scott 2011; Shaw 2012). The extent of patination within the assemblage, again, without the possibility for an effective overview, was not possible to clearly appreciate, but did not appear to be dominant or extensive. Only rarely was potential patination noticed. However, a dedicated geochemical study would be needed in order to fully recognise the degree of patination which is outside the remit of this technological analysis.

While the methodology was geared towards distinguishing general classes of raw material, it became apparent that a more detailed petrological appreciation of the variety of the Houmian raw material, recognised mostly as “flint/chert”, was not possible for this author. While Bewley (1979:27) was confident in identifying the total (887-piece) assemblage as being made up of 88% chert and 12% chalcedony, the present thesis failed in computing an exact percentage division between “flint/chert” and “indeterminate”. This author would, however, tentatively agree with Bewley’s account, as no raw material observed and handled seemed to fall outside the “flint/chert” or chalcedony chategories. All raw materials used appear to be crypto-crystalline silica from pebble and cobble sources.

5.4.1.1 Thermal alteration and Recycling

Thermal alteration or damage, identified as crazing of the surface or potlids, were only identified in two flakes (Table 11). These two flakes both come from Cut C, Layer 2a, spit 2, but from separate batches. No material analysed from Houmian showed evidence of having been recycled, e.g. a patinated flake with some unpatinated flake scars, or a patinated core with unpatinated flake scars.

Thermal alteration	Frequency
No	418
Yes	2
Total	420

Table 11 - Thermal alteration of Houmian lithics.

5.5 Cores

5.5.1 Core assemblage size by cut, layer, and spit

The Houmian core assemblage is not particularly substantial but does seem to be evenly distributed between the 3 cuts represented (Table 12). The fact that most of the Houmian lithic material comes from Layer 2a is reflected in the stratified core assemblage where more than 60% is from this layer, with just over 30% deriving from the earlier Layer 5 (Table 13). Although the designation of lithics to individual spits must, on the basis of surviving contextual information (Bewley 1979: 14), be treated with due caution, it is worth mentioning that 75% of the core assemblage is attributed to spits 3 and 4 (Table 14). Curiously, in Cut A cores are only represented in layers 3 and 5, while in cuts C and C2 cores come exclusively from Layer 2a (Table 15). Having said that, it would seem Layer 2a was not identified in Cut A.

Whereas the complete Houmian assemblage comprises 39 cores, only the 26 attributed to a specified stratigraphic context have been fully included in this study. This unfortunately means that 7 out of 9 prepared and simple prepared cores will be excluded from full analysis. Those unstratified prepared and simple prepared cores will be analysed, but inferences will be sought not overextended. Of the 26 cores from secure context, 24 are unprepared, while two falls into the prepared category. One of these cores are identified as being Levallois and one as simple prepared Levallois. Two of the unprepared cores are identified as discoidal.

	Cut	Frequency	Percent
	A	10	38.5
	C	8	30.8
	C2	8	30.8
	Total	**26**	**100.0**

Table 12 - Houmian cores by Cut

	Level	Frequency	Percent
	2a	16	61.5
	3	2	7.7
	5	8	30.8
	Total	26	100.0

Table 13 - Houmian cores by Level

	Spit	Frequency	Percent
	2	4	15.4
	3	9	34.6
	4	10	38.5
	5	3	11.5
	Total	26	100.0

Table 14 - Houmian cores by Spit

				Cut
		A	C	C2
		Count	Count	Count
Layer	2a	0	8	8
	3	2	0	0
	5	8	0	0

Table 15 - Houmian cores by cut to layer

5.6 Raw material

The likelihood of cores and flakes from the same assemblage, from a stratified context of a few cubic meters, pertaining to associated reduction sequences should not be unfeasible. While raw material identification and sourcing certainly are valuable avenues of enquiry, if both time consuming and specialist endeavours, a simple examination of nodule size compared to size of the presumed associated debitage will immediately provide a clue concerning the possible connection between the two parts of the assemblage.

5.7. Unprepared core size

In **Figure 36, Figure 37 and Figure 38,** the length, width, and thickness of the unprepared core assemblage is presented. The mean size for length, width, and thickness of the cores are 40.5, 33, and 22 mm respectively. Almost 80% is on nodules with the rest of the core blanks being indeterminate (Table 16).

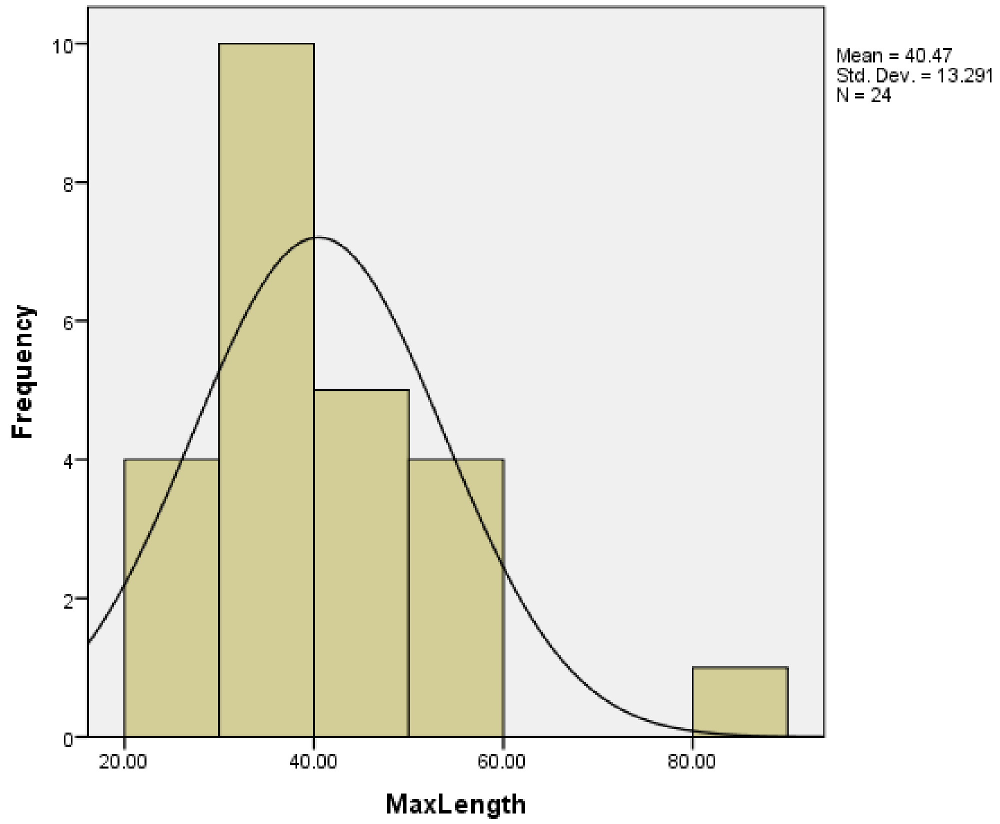

Figure 36 - Max. length for all Houmian unprepared cores.

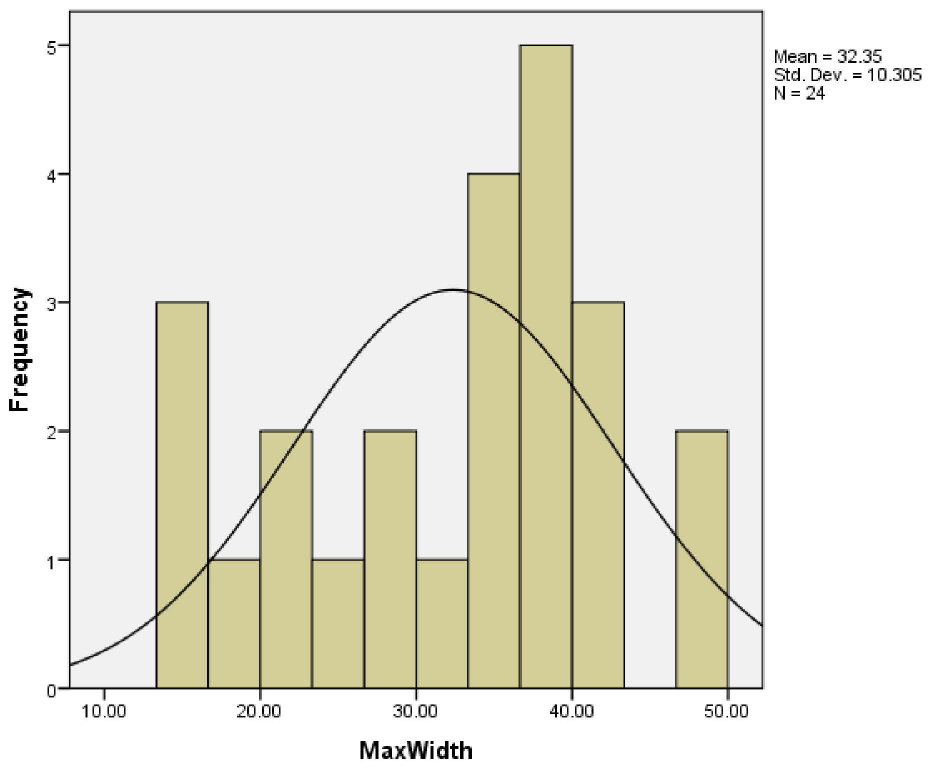

Figure 37 - Max. width for all Houmian unprepared cores.

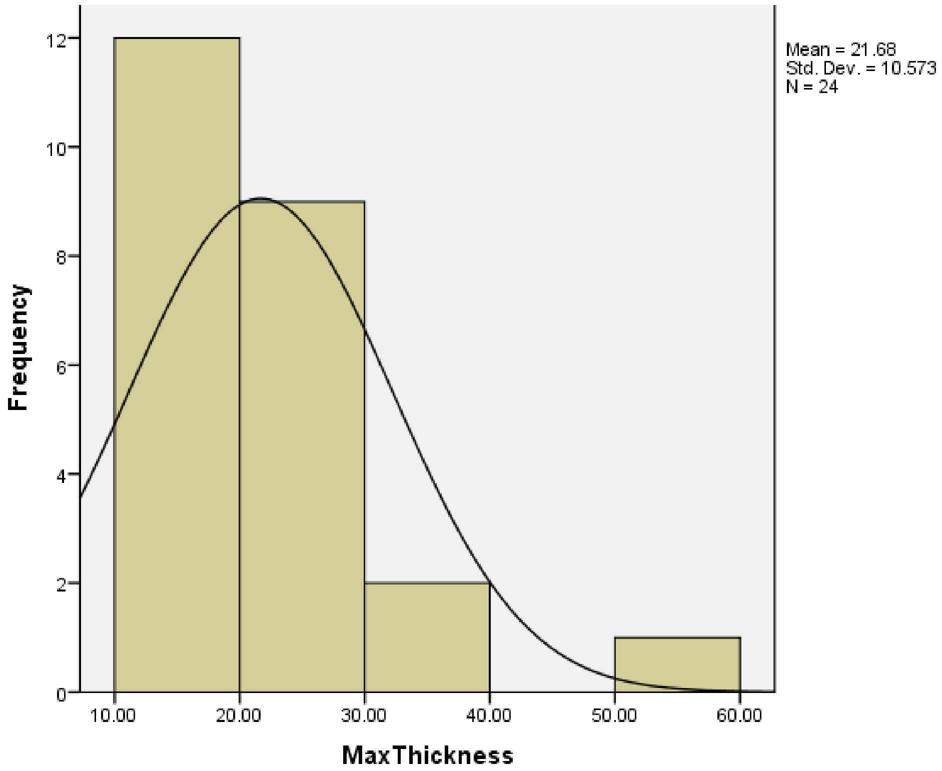

Figure 38 - Max. thickness for all Houmian unprepared cores.

Blank type	Frequency	Percent
Indeterminate	5	20.8
Nodule	19	79.2
Total	24	100.0

Table 16: Houmian unprepared core blanks by blank type

Table 18 shows the divergence in size between nodules retaining blank form and nodules not retaining blank form. The Houmian nodules retaining blank form, although not a statistically valid sample (Table 17), are substantially larger on average than the nodules not retaining blank form. This would appear to make sense if we assume core reduction follows the expected trajectory of decreasing the volume of the core blank concurrent with the core blank losing its original blank form. This is further corroborated by examining the amount of core episodes and total number of flake removals between these two groups of unprepared cores (Table 19). The nodules not retaining original blank form, unsurprisingly, feature more core episodes and a higher number of flake removals than nodules retaining blank form.

	Frequency	Percent
No	16	84.2
Yes	3	15.8
Total	**19**	**100.0**

Table 17 - Blank form retained for Houmian nodules only

		MaxLength Mean	MaxWidth Mean	MaxThickness Mean
Blank Form Retained	No	37.68	33.95	20.09
	Yes	59.50	42.70	37.39

Table 18 - Houmian unprepared cores by size difference between nodules retaining blank form and nodules not retaining blank form

		Total Number of Core Episodes Mean	Total Number of Removals Mean
Blank Form Retained	No	2	10
	Yes	1	5

Table 19 - Houmian unprepared cores by mean number of core episodes and mean number of flake removals to blank form retention

5.7.1 Cortex retention for unprepared cores

Cortex retention also plays a role in the identification of the degree of raw material exploitation. Interestingly, more than 90% of the unprepared core assemblage have remnant cortex preserved (Table 20 and Figure 39). Seen in contrast to the relative size of the cores and the location of the site, this could be a significant behavioural signal, with will be further explored below. There is an almost equal amount of around 30% of cortex retention for the quartiles 0-25%, 25-50%, and 50-75%, if the subdivision of ca. 50% is divided between the latter two. This seems to be a relatively even spread of cortex retention, not readily implying an exhausted body of raw material. The reason for core discard may consequently have to be sought in a behavioural narrative where a conscious choice of functionality or desire of size of end product have prevailed over the ability of the knapper of possibility of continued reduction.

Cortex retention	Frequency	Percent
0%	2	8.3
>0-25%	7	29.2
>25-50%	6	25.0
ca50%	2	8.3
>50-75%	6	25.0
>75%	1	4.2
Total	**24**	**100.0**

Table 20 - Cortex retention on surface area of core

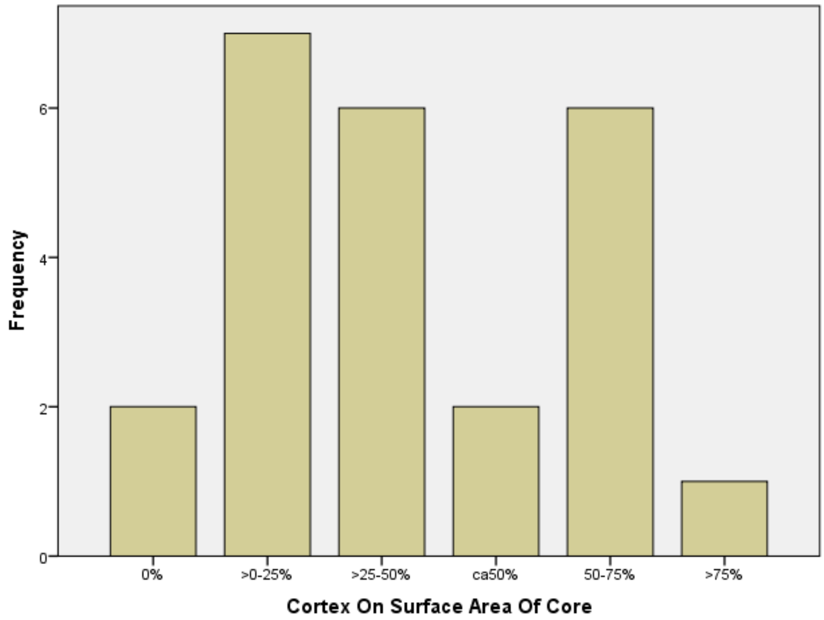

Figure 39 - Cortex retention on surface area of core

5.7.2. Unprepared core technology and reduction

5.7.2.1 Overall core reduction method for unprepared cores

With regards to overall core reduction method, about 2/3 of the cores have been worked through opportunistic or *ad hoc* flaking from unprepared platforms which have left around 46% of the unprepared cores with migrating platforms, 12.5% single platforms and ca. 4% bipolar or opposed platforms. 1/3 of the cores either display discoidal affinities, having been reduced through alternate flaking, or are techno-typologically discoidal cores (Table 21, Figure 40). A substantially reduced or "flattened" discoidal core could potentially be the result of Levallois centripetal recurrent exploitation. This possibility exists as the volume of raw material becomes too small, either for the size of intended Levallois end product or continued reduction, leading the knapper to make use of the striking platform surface (as well as the flake release surface) of the Levallois core for flake detachment, thereby obscuring the techno-typological signature of a prepared core by way of alternate reduction.

Core reduction method	Frequency	Percent
SinglePlatformUnprepared	3	12.5
BipolarUnprepared	1	4.2
MigratingPlatform	11	45.8
Discoidal	8	33.3
Indeterminate	1	4.2
Total	**24**	**100.0**

Table 21 - Characterization of overall core reduction method in Houmian unprepared cores

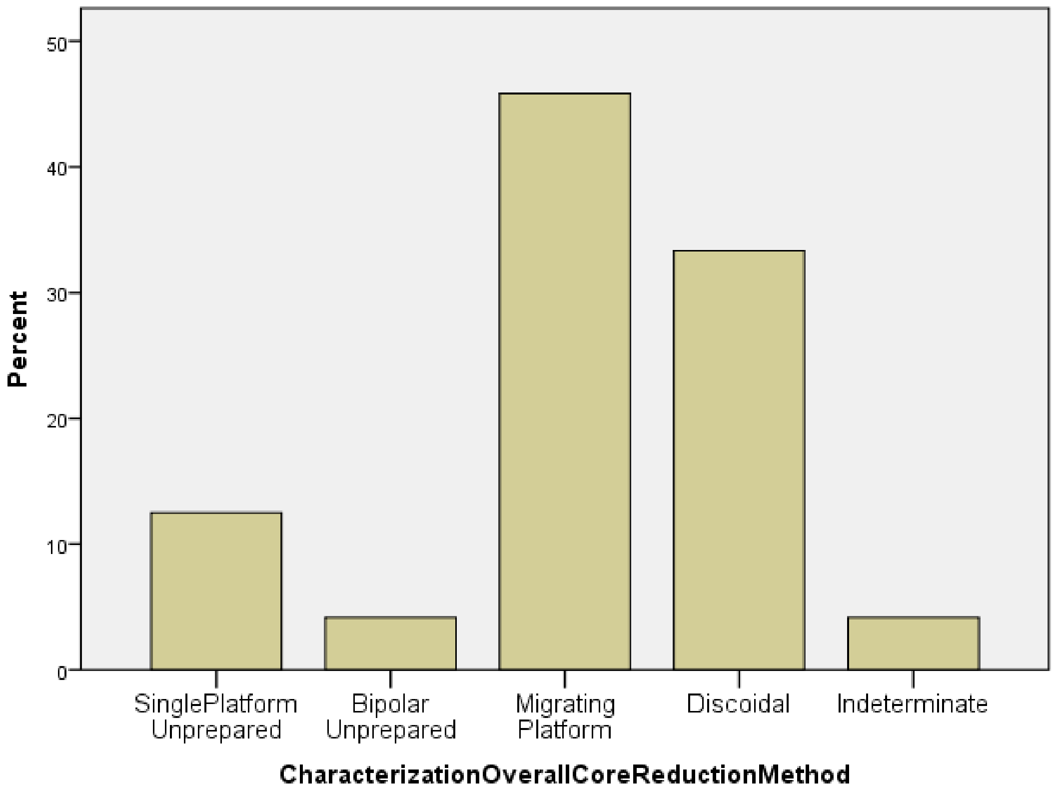

Figure 40 - Characterization of overall core reduction method in Houmian unprepared cores

5.7.3 Core episodes and flake removals for unprepared cores

Looking at the technological behaviour discernible though analyses of unprepared, non-discoidal (*sensu stricto*) core reduction, and extent of exploitation of nodule and other core blank raw material, the degree of utilisation of an individual core will be classified by number of **core episodes** and **number of flake removals** (Chapter 4). The mean number of core episodes for all Houmian unprepared, non-discoidal cores is 1.8, with a mean number of flake detachments of 8 (Table 22 and Table 23).

5.7.3.1 Reduction intensity of unprepared cores

In terms of **reduction intensity**, the amount of flaking attestable through the identification of core episodes demonstrates that just under half the cores have, or rather preserve evidence of, just a single, while just over 75% have either one or two episodes of flake detachments (Table 22-23). This can possibly be attributed to the relatively small size of the cores. Cores with just one episode of reduction exhibit 5.7 flake removals on average, while cores with two episodes of reduction exhibits an average of 3.3 removals for the second episode (Table 24-25).

Number of core episodes	Frequency	Percent
1	10	45.5
2	7	31.8
3	4	18.2
4	1	4.5
Total	**22**	**100.0**

Table 22 - Total number of core episodes for all Houmian unprepared, non-discoidal cores.

The values for core episodes three and four are 2,4 and 1, respectively, but are statistically insignificant, as they number just four and one artefact, respectively. As a subjective bias is inevitable in the designation of order and subsequent recording of core episodes, through the likelihood of incorrectly starting with the episode having most flake scars, caution will be taken not to overemphasise the analytical potential *between* core episodes, but rather focusing on the relative number of core episodes.

As will be discussed in the section on flakes below, just three core-on-flakes were identified in the Houmian assemblage. This is surprising given the location of the site, where the assumption of raw material scarcity translating into utilisation of flakes as cores, either as recycling or through flake core blanks transported into the site from elsewhere, seemed warranted (Lindly 1997). With the Greater Zab River running in relatively close proximity to the site, procurement of nodules from its stream and riverbed is a likely alternative source.

Number of removals	Frequency	Percent
2	1	4.5
3	1	4.5
4	3	13.6
5	1	4.5
6	1	4.5
7	3	13.6
8	2	9.1
9	3	13.6
10	3	13.6
11	1	4.5
12	1	4.5
16	1	4.5
17	1	4.5
Total	**22**	**100.0**

Table 23 - Total number of removals for all Houmian unprepared, non-discoidal cores.

Number of flake removals per core episode 1	Frequency	Percent
1	2	9.1
2	3	13.6
3	2	9.1
4	3	13.6
5	2	9.1
6	1	4.5
7	3	13.6
8	3	13.6
10	1	4.5
11	1	4.5
17	1	4.5
Total	**22**	**100.0**

Table 24 - Number of flake removals per core episode 1 for all Houmian unprepared, non-discoidal cores.

Number of flake removals per core episode 2	Frequency	Valid Percent
1	5	41.7
2	1	8.3
3	2	16.7
5	1	8.3
6	2	16.7
10	1	8.3
Total	**12**	**100.0**

Table 25 - Number of flake removals per core episode 2 for all Houmian unprepared, non-discoidal cores.

5.8 Core size compared to largest flake detachment

Considering the findings above regarding mean sizes of discarded cores, these are here compared to size of the largest flake detachment recorded on each core. Where length, width, and thickness of the cores were 40.5, 33, and 22 mm, respectively, the mean dimensions of largest scars are about 30.5 mm and 18.5 mm for length and width, respectively (Figure 41 and Figure 42). Below, when looking at the debitage population of the assemblage, we will see to what extent flake sizes matches with scar sizes on cores.

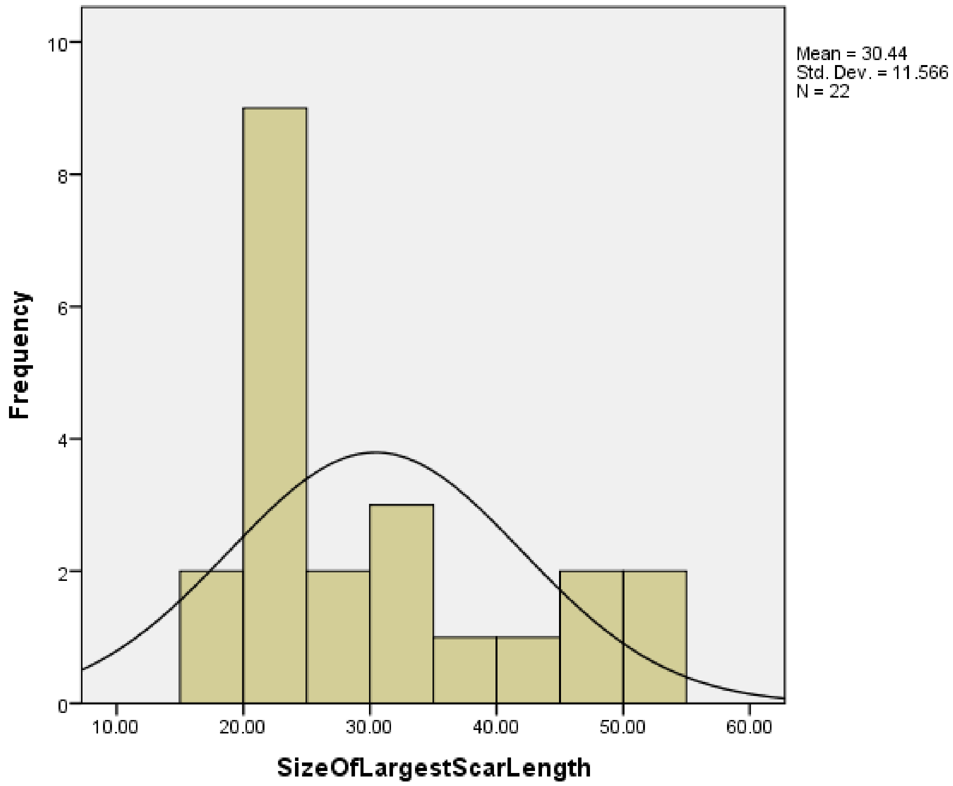

Figure 41 - Size of largest flake scar length for all Houmian unprepared, non-discoidal cores.

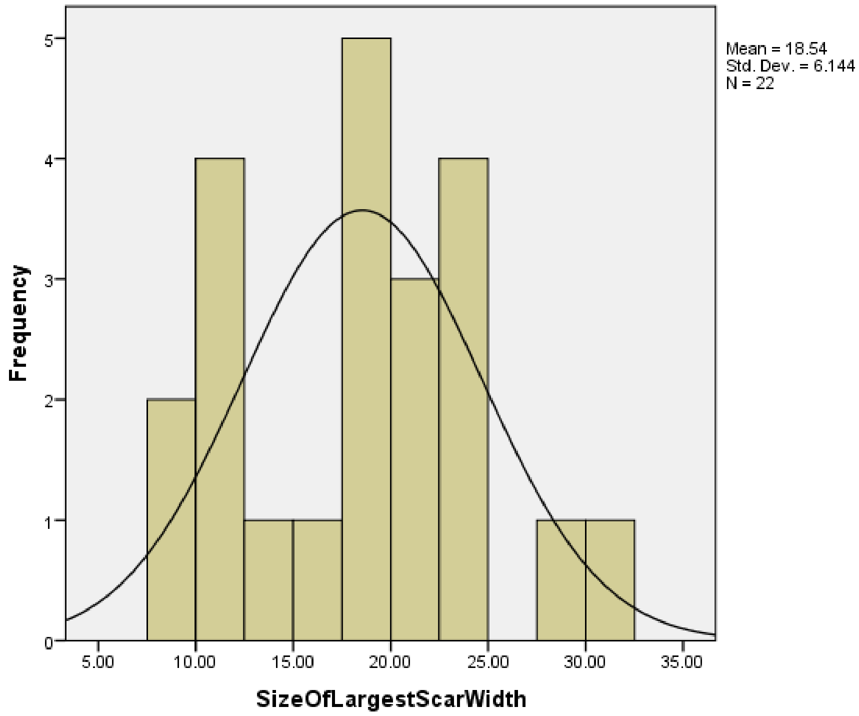

Figure 42 - Size of largest flake scar width for all Houmian unprepared, non-discoidal cores.

5.9 Prepared core technology and reduction

At Houmian, some degree of prepared core reduction is likely to have taken place suggested by the inclusion within the lithic assemblage of Levallois cores and flakes. The core portion of this assemblage consists of both prepared and simple prepared Levallois, both of which are discussed under the umbrella of "prepared" core technology. While these simple prepared cores do not fully comply with the Boëda definition (1986, 1995), enough traits are present (i.e. criterion 1-2 and 4-6 of Boëda's list of traits, see Chapter 4) to incorporate them into the "prepared" core category. Only two out of eight prepared cores within the Houmian assemblage can be assigned to a stratified context. In order to provide a more comprehensive insight into the technological choices pertaining to prepared core reduction at Houmian, we will here first describe the two stratified cores, followed by a description of the unstratified, concluding with a combined appreciation of both stratified and unstratified prepared cores.

5.9.1.1 Prepared core dimensions

The two stratified prepared cores, one identified as Levallois and one as simple prepared Levallois, come from Cut A, Layer 5, Spit 4, and Cut C, Layer 2a, Spit 2, respectively. The fully prepared Levallois core is larger than the simple prepared core as can be appreciated by comparing dimensions. The fully prepared Levallois core measures 52.41 mm, 58.81 mm, and 24.29 mm for length, width, and thickness, respectively, while the proportions for the simple prepared Levallois core are 31.64 mm, 27.47 mm, and 14.02 mm, respectively (Table 26).

The unstratified prepared core assemblage consists of six cores, four being simple prepared and two fully Levallois. They have mean length, width, and thickness of 37 mm, 31 mm, and 14 mm, respectively (Table 27).

	Minimum	Maximum	Mean
Max Length	31.64	52.41	42.0250
Max Width	27.47	58.81	43.1400
Max Thickness	14.02	24.29	19.1550

Table 26 - Dimensions of stratified prepared cores

	Minimum	Maximum	Mean
MaxLength	31.52	42.15	37.3450
MaxWidth	26.30	38.53	31.0933
MaxThickness	12.91	17.24	14.9133

Table 27 - Dimensions of unstratified prepared cores

The stratified fully prepared Levallois core described above is an outlier within the prepared core assemblage when comparing size, which can be seen in tables 28-29. Similarly, within the unprepared core assemblage, presented above, one core is much larger than the others (see maximum dimensions in Table 30), and considered an outlier (tables 30-31).

Consequently, it would seem to make most sense analytically to exclude these two outliers before comparing the prepared and unprepared core assemblages.

With the caveat that the core sample for both prepared and unprepared cores are quite small, it is still interesting to see that both types of discarded cores are essentially the same size (tables 29-31). With a mean length ranging between just 36-38 mm, and with mean width absolutely identical, only mean thickness stands out, and in this instance only by comparison with the two former measurements, seeing prepared cores slightly thinner. This is arguably more to do with reduction technique than with desired size of end product: The *ad hoc* exploitation of a non-hierarchical unprepared core will usually see it attain a more rounded form, as reduction will not necessarily discriminate between the various volumetric surfaces on the core. Conversely, a prepared core will have a tendency towards becoming flatter in plan-view, as reduction is focused on one volumetric area and exploitation structured to generally produce thicker end products. This is likely what we are seeing here.

	Minimum	Maximum	Mean
MaxLength	31.52	52.41	38.5150
MaxWidth	26.30	58.81	34.1050
MaxThickness	12.91	24.29	15.9737

Table 28 - Dimensions of all prepared cores (with outlier)

	Minimum	Maximum	Mean
MaxLength	31.52	42.15	36.5300
MaxWidth	26.30	38.53	30.5757
MaxThickness	12.91	17.24	14.7857

Table 29 - Dimensions of all prepared cores (without outlier)

	Minimum	Maximum	Mean
MaxLength	21.42	85.84	40.3436
MaxWidth	14.06	48.51	31.4305
MaxThickness	11.79	59.80	21.2518

Table 30 - Dimensions of unprepared cores (with outlier)

	Minimum	Maximum	Mean
MaxLength	21.42	54.74	38.1771
MaxWidth	14.06	42.47	30.6171
MaxThickness	11.79	37.71	19.4162

Table 31 - Dimensions of unprepared cores (without outlier)

5.9.1.2 Techno-typological variation

Combining the stratified and unstratified prepared core assemblage, we will now take a look at their techno-typological variation, for the purpose of getting an idea of the nature of the prepared cores as a category. We do this to appreciate whether the two stratified cores can be said to be representative of the ones not stratified.

5.9.1.3 Number of preparatory scars on striking platform and flaking surfaces

Looking at number of preparatory scars on striking platform surface, detachments range from 3 to 13 with a mean of 8 (Table 32). These figures are almost identical for the number of preparatory scars on flaking surface, which ranges between 3 and 12 with a mean of 7 (Table 33).

Number of preparatory scars	Frequency	Percent
3	1	12.5
6	2	25.0
9	2	25.0
11	1	12.5
12	1	12.5
13	1	12.5
Total	**8**	**100.0**

Table 32 - Number of preparatory scars on striking platform surface

Number of preparatory scars	Frequency	Percent	Valid Percent
3	1	12.5	12.5
4	1	12.5	12.5
5	2	25.0	25.0
10	1	12.5	12.5
11	1	12.5	12.5
12	2	25.0	25.0
Total	**8**	**100.0**	**100.0**

Table 33 - Number of preparatory scars on flaking surface

5.9.1.4 Number of definite Levallois end products detached from final flaking surface

The number of definite (i.e. discernible, preferred) Levallois end products detached from the final flaking surface of a core is evenly divided with 5 cores having only 1 definite end product, and 3 cores showing evidence of 2 definite end products (Table 34).

These end products on average are 22 mm long and 19 mm wide (Table 35 and Table 36), making them slightly shorter on average than those detached from the unprepared cores presented above, but with an identical width (figures 35-36). As with the unprepared cores, we will later establish whether size of definite Levallois end products within the Houmian assemblage match the size of the prepared cores, and as such could have been products of reduction associated with these cores. It was not possible to establish thickness of the end products/flake scars for either the prepared or unprepared cores.

Number of definite Levallois products	Frequency	Percent
1	5	62.5
2	3	37.5
Total	**8**	**100.0**

Table 34 - Number of definite Levallois products detached from final flaking surface

Length	Frequency	Percent
13.76	1	12.5
14.28	1	12.5
16.12	1	12.5
19.93	1	12.5
21.71	1	12.5
23.49	1	12.5
31.90	1	12.5
35.35	1	12.5
Total	**8**	**100.0**

Table 35 - Dimensions of final Levallois product length

Width	Frequency	Percent
11.58	1	12.5
13.44	1	12.5
15.72	1	12.5
15.89	1	12.5
17.00	1	12.5
18.91	1	12.5
22.45	1	12.5
38.71	1	12.5
Total	**8**	**100.0**

Table 36 - Dimensions of final Levallois product width

5.9.1.5 Method of preparation of final flaking surface

Five out of eight cores have been prepared centripetally, with other forms of preparation showing bipolar (opposed), and convergent unipolar reduction, with one being unidentifiable (Table 37). The reason for the higher number of centripetally prepared cores can possibly be explained as an effect of intensity of reduction, whereby an element of opportunism coupled with the realities of remaining core-surface real estate might end up dictating a centripetal reduction approach as the only viable choice.

Method of preparation	Frequency	Percent
Bipolar	1	12.5
Convergent Unipolar	1	12.5
Centripetal	5	62.5
Indeterminate	1	12.5
Total	**8**	**100.0**

Table 37 - Method of preparation of final flaking surface

5.9.1.6 Method of exploitation of final flaking surface

When it comes to method of exploitation of final flaking surface four out of five centripetally prepared cores are associated with lineal exploitation (tables 38-39), meaning that the centripetal reduction usually is followed by only one episode of exploitation with could lend support to the suggested assumption that centripetally reduced cores might be evidence of imminent raw material exhaustion (of the core). This is echoed in the lack of indication of earlier flaking surface (Table 40) where just three out of eight cores retain evidence of having had a preferred end product detached prior to the final one. As this could have been obscured by the preparation, an unequivocal statement on previous flaking surfaces cannot be offered.

Method of exploitation	Frequency	Percent
Unexploited	1	12.5
Lineal	5	62.5
CentripetalRecurrent	2	25.0
Total	**8**	**100.0**

Table 38 - Method of exploitation of final flaking surface

Method of exploitation	Centripetal recurrent	Lineal	Unexploited	Total
Bipolar	1	0	0	1
Centripeal	0	4	1	5
Convergent unipolar	0	1	0	1
Indeterminate	1	0	0	1

Table 39 - Method of exploitation of final flaking surface by Method of preparation of final flaking surface

Earlier flaking surface	Frequency	Percent
Yes	3	37.5
No	5	62.5
Total	**8**	**100.0**

Table 40 - Evidence of earlier flaking surface

5.9.1.7 Levallois end products detached from final flaking surface

Half of the Levallois end products detached from the final flaking surface of the prepared cores are flakes. One Levallois point, one overshot, one unexploited prepared surface, and one unidentified makes up the rest (Table 41).

Morphology	Frequency	Percent
Unexploited	1	12.5
Flake	4	50.0
Point	1	12.5
Overshot	1	12.5
Indeterminate	1	12.5
Total	**8**	**100.0**

Table 41 - Morphology of Levallois products from final flaking surface

5.9.1.8 Extent of cortex-, position of cortex-, and remnant distal ends on striking platform surfaces

In contrast to the assumption above that centripetal preparation together with lineal exploitation could be considered to suggest raw material exhaustion, the amount of remnant cortex left on the cores seem to imply that the cores were perhaps not significantly larger when reduction commenced compared to when they were discarded. This can be seen in Table 42, where the extent of cortex on striking platform surface show that four of eight cores retains more than 75% cortex. Three of those four cores have centripetal preparation and lineal exploitation. The specific position of the cortex on the striking platform does not immediately lend itself to further insight (Table 43). A final indication of relative original size of the cores is offered by the recognition of remnant distal ends on their striking platform surfaces (Table 44). A core with remnant distal flake scars would necessarily have been substantially larger than its present shape. In three of eight cores this is the case, and two of these preserves more than 75% cortex together with centripetal preparation and lineal exploitation.

Extent of cortex on striking platform	Frequency	Percent
0%	1	12.5
>0-25%	3	37.5
>75%	4	50.0
Total	**8**	**100.0**

Table 42 - Extent of cortex on striking platform surface

Portion of cortex on striking platform	Frequency	Percent
None	1	12.5
OneEdgeOnly	1	12.5
MoreThanOneEdge	2	25.0
CentralAndOneEdge	2	25.0
CentralAndMoreThanOneEdge	2	25.0
Total	**8**	**100.0**

Table 43 - Portion of cortex on striking platform surface

	Frequency	Percent
Yes	3	37.5
No	5	62.5
Total	**8**	**100.0**

Table 44 - Remnant distal ends on striking platform surface

5.10 Flakes

5.10.1 Flake assemblage size by cut, layer, and spit.

394 pieces of debitage, here collectively referred to as flakes, have been analysed from the site of Houmian. They represent material recovered from two of the four lithic-rich cuts, namely cuts C and C2 (Table 45). Of these, besides four pieces which could not be satisfactorily attributed to a specific layer due to lack of contextual information, all flakes are from Layer 2a (Table 46). There are no flakes from Layer 5 recorded from cuts C or C2, as it would appear these two cuts only reach as far as Layer 3. Within Layer 2a, the distribution of flakes, from the uppermost Spit 1 to the lowermost artefact-bearing Spit 5, seem to conform to what can be called a normal distribution with Spit 3 being the richest (Table 47 and Figure 43). This assumption does not take into account the possibility of differences in size-of-depth of the individual spits. Looking at the flake distribution, by spit, from each of these two cuts separately, the pattern of distribution in Cut C is almost identical to the combined one (tables 48-49 and Figure 44). This might be due to the fact Cut C incorporates almost 80% of the combined flake assemblage. The distribution observable in Cut C2 is more even across spits, with flakes from three consecutive spits having about the same amount of flakes (Tables 50-51 and Figure 45). These observations will, for reasons mentioned above, not be attributed too much significance, but are stated here for the sake of transparency.

	Cut	Frequency	Percent
	C	311	78.9
	C2	83	21.1
	Total	**394**	**100.0**

Table 45 - All Houmian flakes by cut

Layer	Frequency	Percent
?	4	1.0
2a	390	99.0
Total	**394**	**100.0**

Table 46 - All Houmian flakes by layer

Spit	Frequency	Percent
1	6	1.5
2	96	24.4
3	145	36.8
4	124	31.5
5	23	5.8
Total	**394**	**100.0**

Table 47 - All Houmian flakes by spit

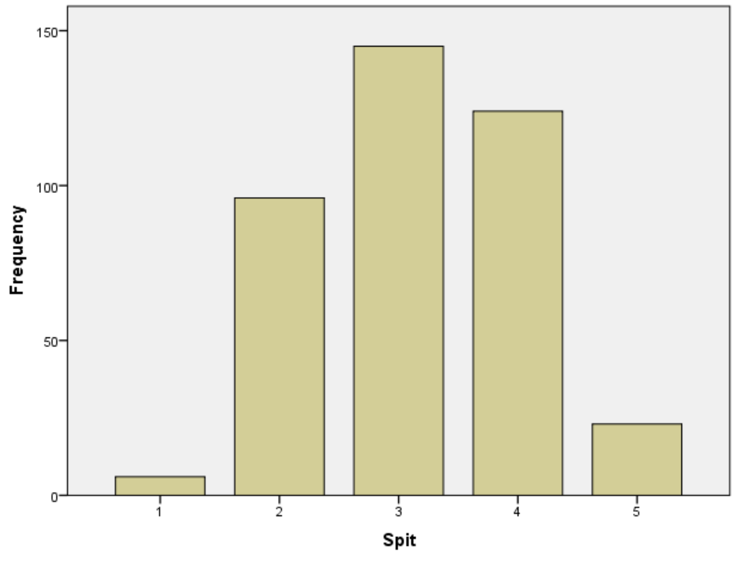

Figure 43 - All Houmian flakes by spit

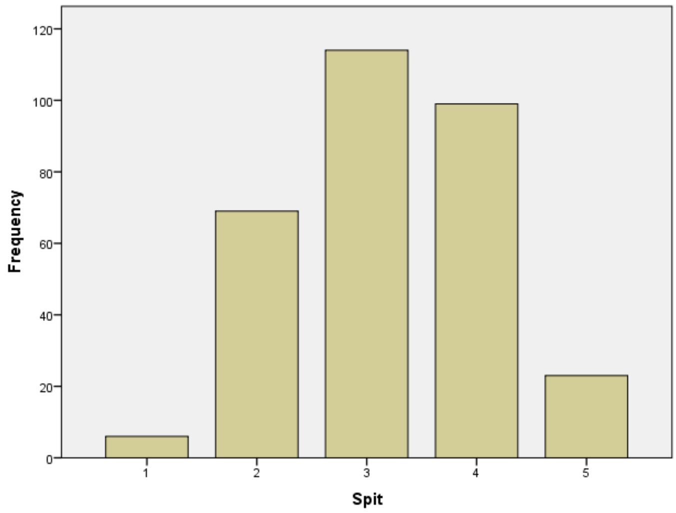

Figure 44 - Houmian flakes from Cut C by spit

Layer	Frequency	Percent
?	4	1.3
2a	307	98.7
Total	**311**	**100.0**

Table 48 - Houmian flakes from Cut C by layer

Spit	Frequency	Percent
1	6	1.9
2	69	22.2
3	114	36.7
4	99	31.8
5	23	7.4
Total	**311**	**100.0**

Table 49: Houmian flakes from Cut C by spit

Layer	Frequency	Percent
2a	83	100.0

Table 50 - Houmian flakes from Cut C2 by layer

Spit	Frequency	Percent
2	27	32.5
3	31	37.3
4	25	30.1
Total	**83**	**100.0**

Table 51 - Houmian flakes from Cut C2 by spit

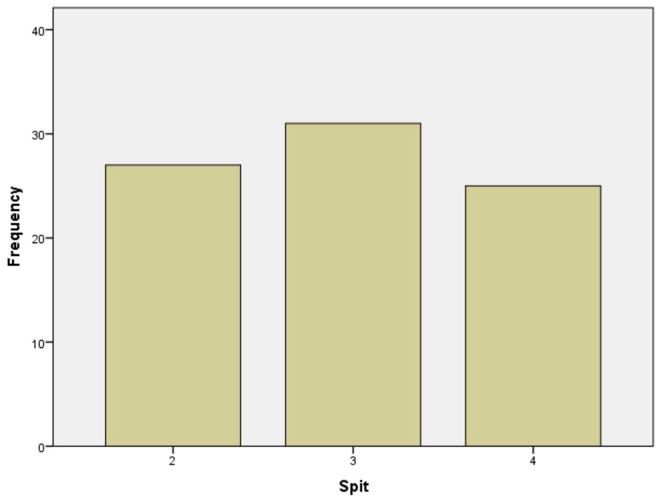

Figure 45 - Houmian flakes from Cut C2 by spit

5.10.2 Flake assemblage by techno-typology

5.10.2.1 Division of assemblage by data class

The following study of the flake assemblage from Houmian will mainly focus on analyses of whole flakes. Proximal fragments will be included for studies on platform characteristics such as butt type and platform length and width. Broken fragments with retouch will be included when looking at retouch. The four flakes without exact stratigraphical context are excluded from analysis. The three core-on-flakes will be analysed in this section as they are conceptualised as debitage by origin, and only after detachment (whether intended as a core by inception or not) transformed into core blanks.

The Houmian flake assemblage analysed here, after exclusion of the four unretouched pieces with inconclusive stratigraphic provenience, but still including the three core-on-flakes, total 390 pieces (Table 52). The two main components are unretouched and retouched flakes, with the latter constituting 12.1%. Some of these retouched flakes can be defined as formal tools, and will be described below. There is no bifacial tool component like handaxes in the Houmian assemblage.

Focusing the study on whole flakes, the assemblage population decreases to 210 pieces (Table 53). However, the ratio of retouched flakes stays almost the same with 12.9%, even though the assemblage has been all but halved.

Unretouched flakes make up 183, or close to 90% of the whole flake population. Including one unbroken, i.e. whole, core-on-flake within the retouched flake population, modified pieces number 27 (Table 53).

Data on broken flakes can be viewed in Table 54 to Table 58.

Data class	Frequency	Percent
CoreOnFlake	3	.8
RetouchedFlake	44	11.3
UnretouchedFlake	343	87.9
Total	**390**	**100.0**

Table 52 - All Houmian flakes, whole and broken, unretouched and retouched, including cores-on-flake

Data class	Frequency	Percent
CoreOnFlake	1	.5
RetouchedFlake	26	12.4
UnretouchedFlake	183	87.1
Total	**210**	**100.0**

Table 53 - Houmian whole flakes, unretouched and retouched, Cores-on-Flake

Data class	Frequency	Percent
CoreOnFlake	2	1.1
RetouchedFlake	18	10.0
UnretouchedFlake	160	88.9
Total	**180**	**100.0**

Table 54 - Houmian broken flakes, unretouched and retouched, Cores-on-Flake: by data class

	Retouched flakes	Unretouched flakes
Portion of flake	Count	Count
Distal	2	49
Longitudinal(Siret)	0	6
Mesial	2	23
Obscured	0	1
Proximal	14	83

Table 55 - Houmian broken flakes, unretouched and retouched, Cores-on-Flake: by portion of flake

	Unretouched flakes
Portion of flake	Count
Distal	48
Longitudinal (Siret)	6
Mesial	23
Obscured	1
Proximal	82

Table 56 - Houmian broken flakes, unretouched: by portion of flake

Data class	Frequency	Percent
CoreOnFlake	2	10.0
RetouchedFlake	18	90.0
Total	**20**	**100.0**

Table 57 - Houmian broken flakes, retouched, Cores-on-Flake: by data class

	Core-on-flake	Retouched flake
Portion of flake	Count	Count
Distal	0	2
Longitudinal (Siret)	0	0
Mesial	0	2
Obscured	0	0
Proximal	2	14

Table 58 - Houmian broken flakes, retouched, Cores-on-Flake: by portion of flake

5.10.3 Complete flakes

5.10.3.1 Flake dimensions

The assemblage of whole flakes has mean dimensions of 28, 19, and 5 mm for **length, width, and thickness**, respectively (figures 46-48). The difference between max flake length and flake length P is not substantial, with the latter mean measured at 26 mm (figure 49). The correlation between the two separate length measurements would suggest that the Houmian flake population have distal symmetry (or at least not asymmetry), i.e. that, generally, neither right nor left lateral side is elongated relative to the other, but rather that the furthest distal point of flakes is centred along the axis of percussion, measured from the point of percussion to the furthest point at the distal margin. A slight bimodality might be observed in the frequency distribution for max flake length, with a more distinguished one visible for flake length P. Maximum flake width demonstrate a more or less normal distribution, while maximum flake thickness has a positively skewed distribution. Platform width and platform thickness are 12 and 4 mm, respectively (figures 50-51).

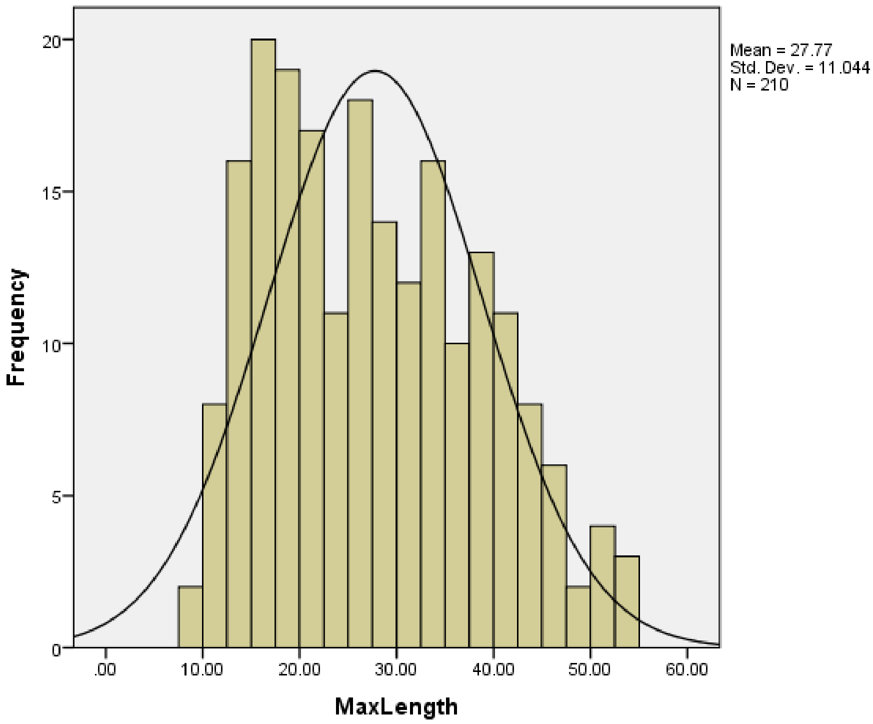

Figure 46 - Houmian complete flakes: Max. length

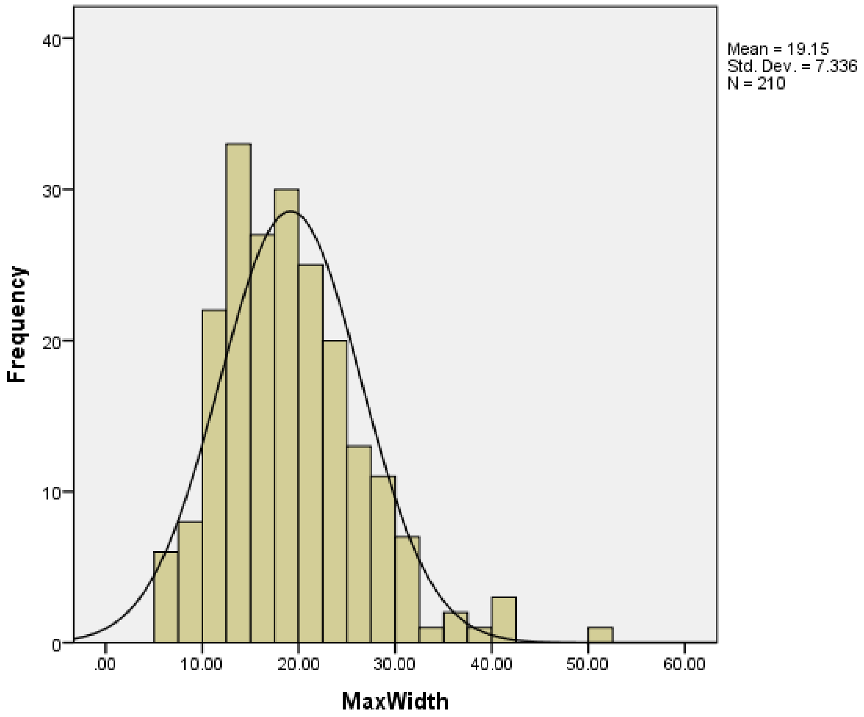

Figure 47 - Houmian complete flakes: Max. width

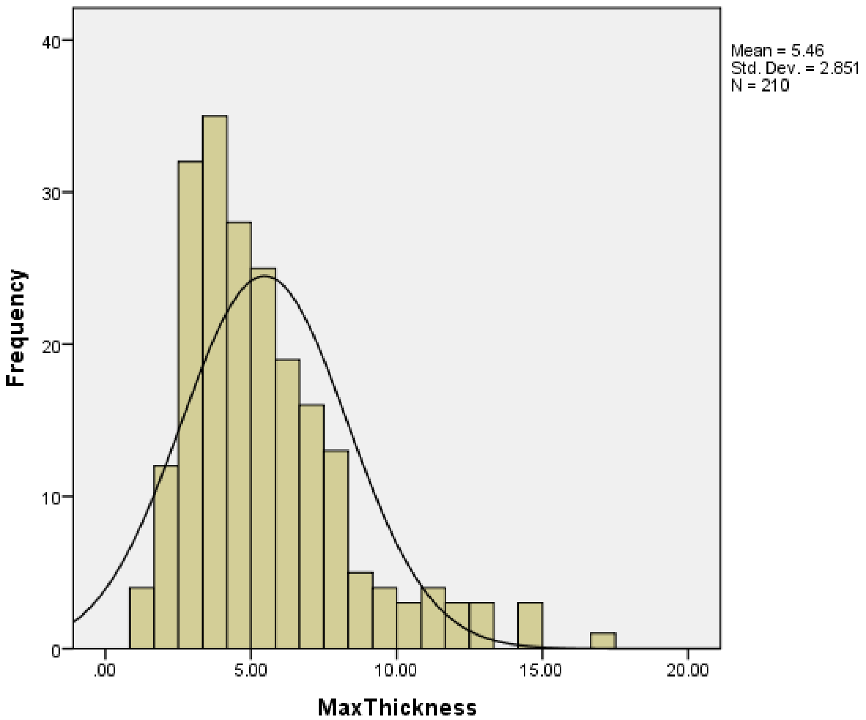

Figure 48 - Houmian complete flakes: Max. thickness

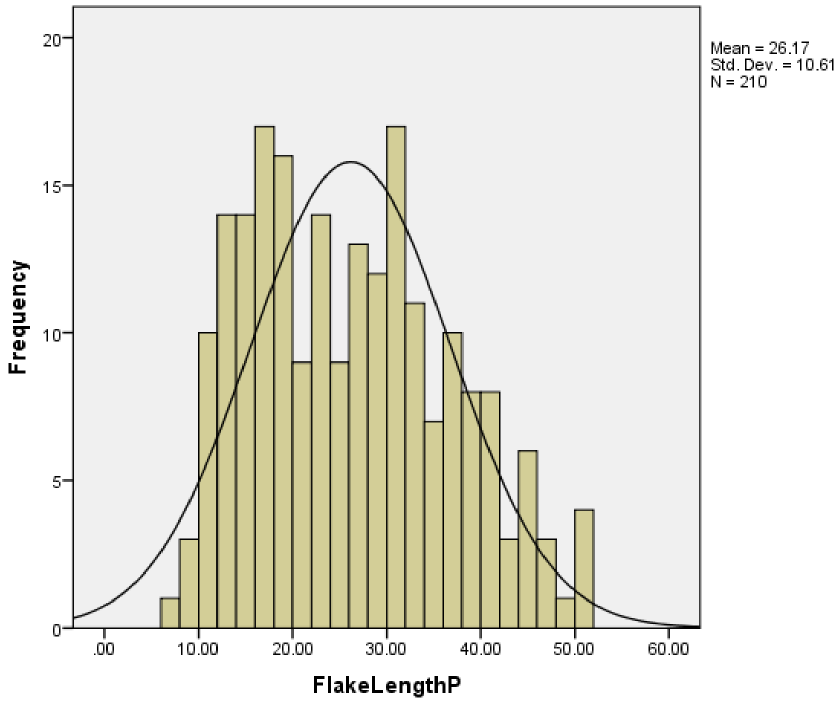

Figure 49 - Houmian complete flakes: Max. length P

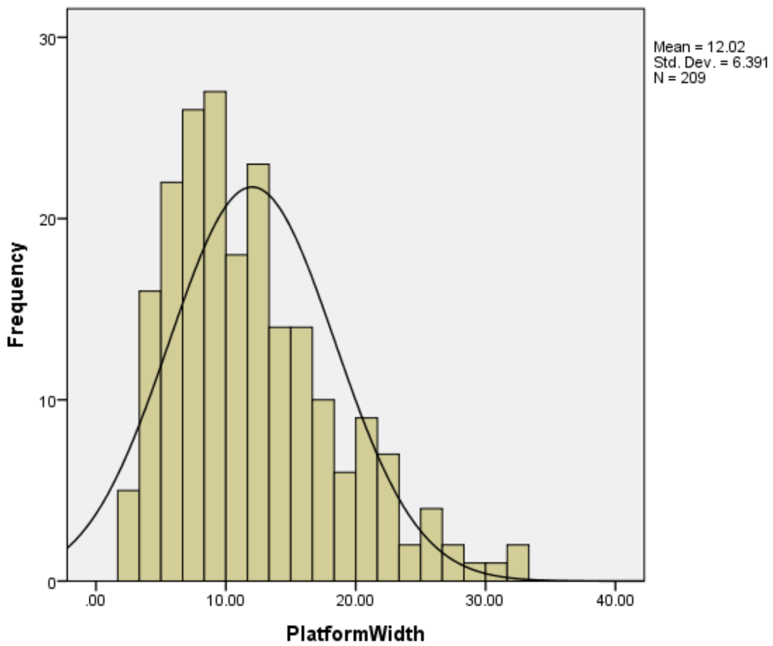

Figure 50 - Houmian complete flakes: Platform width

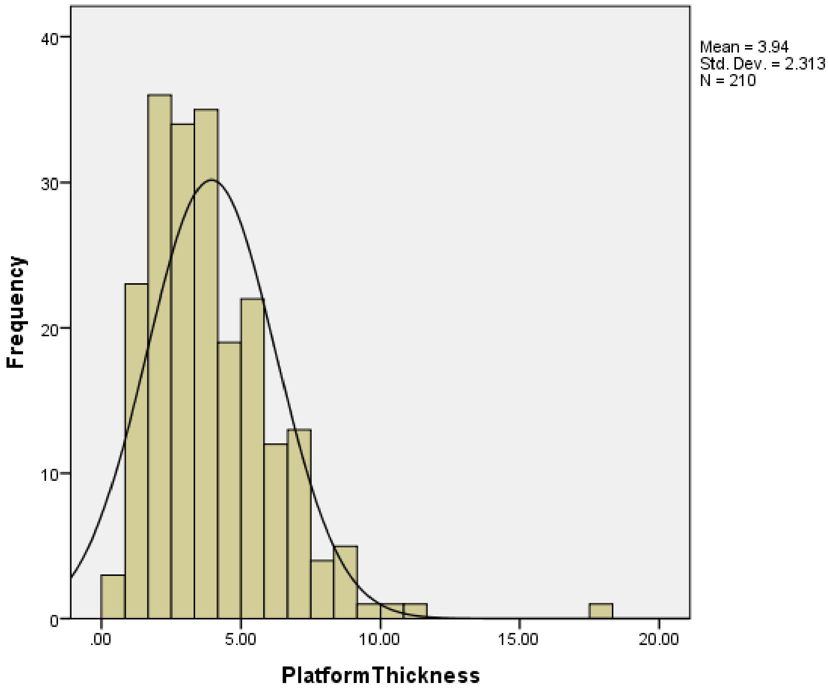

Figure 51 - Houmian complete flakes: platform thickness

5.10.3.2 Dorsal indices of flakes

The mean **dorsal scar count** is 3.5 per flake, with between one to six being the most prevalent. Only 3.3% of the flakes are wholly cortical (Table 59).

Looking at **dorsal scar pattern**, 26.2% of the Houmian flakes have multiple scars exclusively detached from a proximal direction. This number could rise to as much as 50% if non-complex scar pattern categories including some combination of proximal detachment (i.e. 1, 3, 7, and 9, see Chapter 4) are merged (Table 60 and Figure 52). 15.7% of the flakes have a complex, i.e. non-opposed scar pattern, but only around 5.7% can be classified as radial. This low number of flakes with complex scar patterns would seem to indicate that only limited core rotation was employed by the knappers at the Houmian rock shelter. This either indicates a lack of raw material exhaustion of core blanks, or that core blanks had become so small as to preclude complex exploitation.

Dorsal scar count	Frequency	Percent
0	7	3.3
1	18	8.6
2	31	14.8
3	56	26.7
4	40	19.0
5	30	14.3
6	18	8.6
7	6	2.9
8	3	1.4
9	1	.5
Total	**210**	**100.0**

Table 59 - Houmian complete flakes: Dorsal scar count

Dorsal scar pattern	Frequency	Percent
Proximal	55	26.2
Distal	1	.5
IndeterminateUnidirProximalDistal	1	.5
Right	2	1.0
Left	2	1.0
BidirectionalProximalDistal	11	5.2
BidirectionalLateral	3	1.4
IndeterminateUni-BidirProximalDistal	38	18.1
IndeterminateUni-BidirLat	1	.5
Multi-directional	21	10.0
WeaklyRadial	8	3.8
StronglyRadial	1	.5
Indeterminate(but radial)	3	1.4
WhollyCortical	7	3.3
Obscured	3	1.4
Indeterminate	53	25.2
Total	**210**	**100.0**

Table 60 - Houmian complete flakes: Dorsal scar pattern

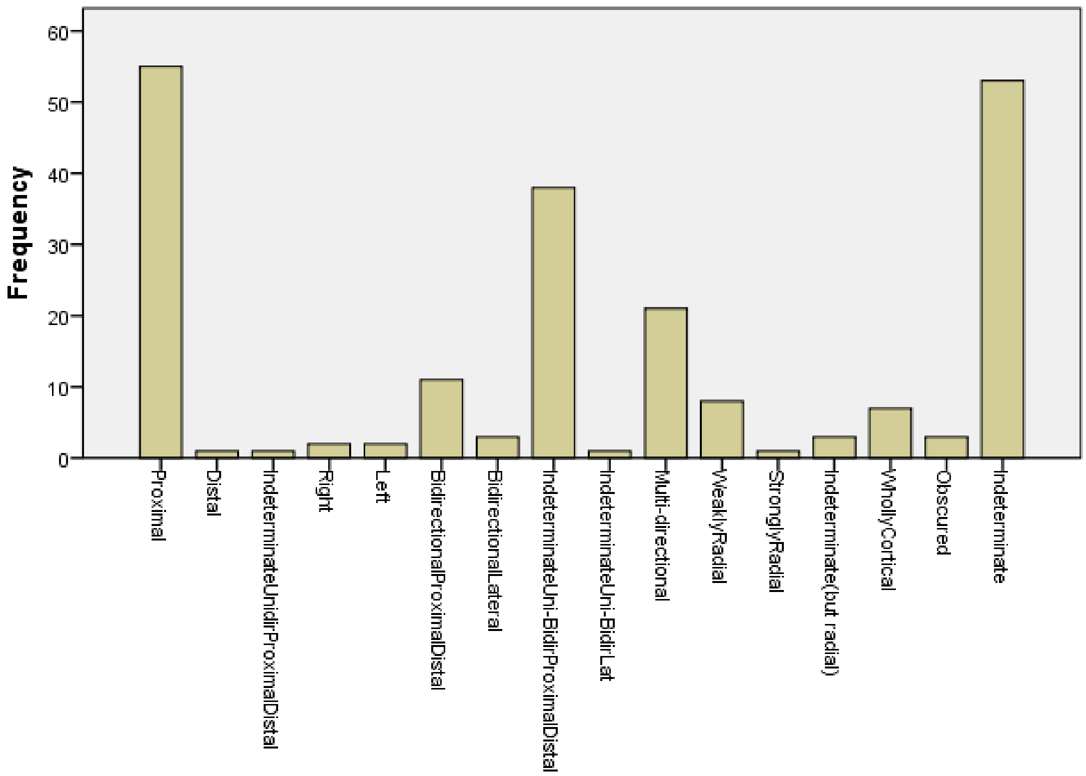

Figure 52 - Houmian complete flakes: Dorsal scar pattern

In terms of **cortex** preservation on the **dorsal surface of flakes**, it is evident that the Houmian assemblage generally do not retain much (Table 61 and Figure 53). More than 50% of the flakes are completely without cortex, and almost 80% have less than 25% cortex. Only around 6% preserving more than 75%. This picture is emphasised when the cortex categories are grouped in 3 clusters (Table 62 and Figure 54). This would seem to indicate that the Houmian assemblage represent late stages of core reduction. Alternatively, already decorticated nodules could have been brought into the site, or larger cortical flakes turned into tools, retouched, used, re-sharpened at the site, thereby obscuring the original proportion of cortical flakes.

The impression of a largely tertiary (i.e. in a techno-typological context of flake reduction) flake assemblage suggested by the dorsal cortex preservation signature, is corroborated though the observation of the **location of cortex** on the flakes (Table 63 and Figure 55). On 85% of the flakes retaining cortex, the distribution is restricted to the dorsal only, i.e. that this portion of blanks does not preserve cortex on the platform. Cortex retention on the platform of a flake would imply an early, i.e. primary or secondary, phase of core reduction rather than a tertiary.

Dorsal cortex on flake		Frequency	Percent
	0%	118	56.2
	1-25%	46	21.9
	26-50%	9	4.3
	ca50%	19	9.0
	51-75%	5	2.4
	76-99%	6	2.9
	100%	7	3.3
	Total	**210**	**100.0**

Table 61 - Houmian complete flakes: Dorsal cortex on flake

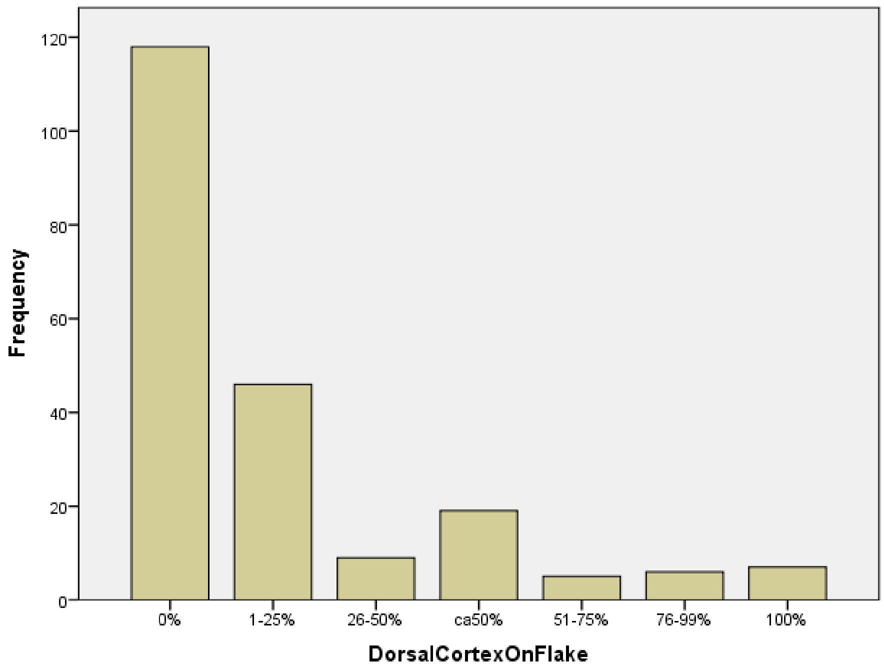

Figure 53 - Houmian complete flakes: Dorsal cortex on flake

	Frequency	Percent
0-25%	164	78.1
25-75%	33	15.7
75-100%	13	6.2
Total	**210**	**100.0**

Table 62 - Houmian complete flakes: Dorsal cortex on flake grouped in 3 clusters

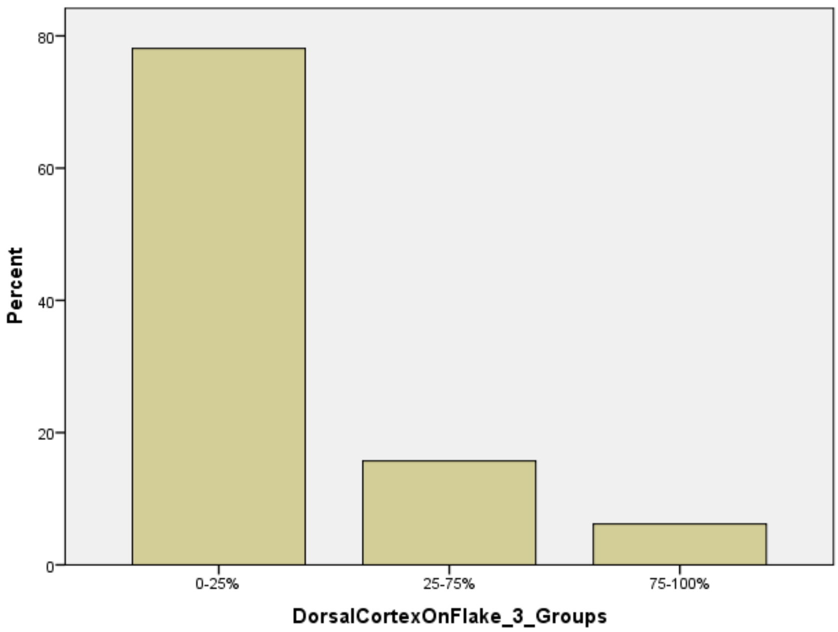

Figure 54 - Houmian complete flakes: Dorsal cortex on flake grouped in 3 clusters

	Frequency	Percent
DorsalOnly	78	37.1
PlatformOnly	4	1.9
DorsalAndPlatform	10	4.8
None	118	56.2
Total	**210**	**100.0**

Table 63 - Houmian complete flakes: Flake cortex location

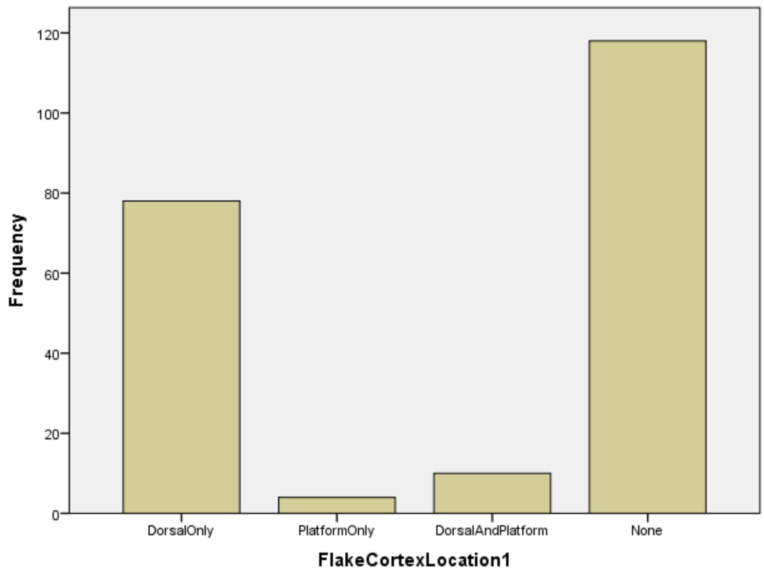

Figure 55 - Houmian complete flakes: Flake cortex location

5.10.3.3 Proximal indices of flakes

Turning to flake **platform** morphology, some diversity is attested to. While almost half the assemblage has plain butts, technologically noteworthy types, in terms of reduction stages, include facetted and dihedral platforms at 14% and 8%, respectively (Table 64 and Figure 56). Early stage reduction butt types such as cortical and mixed are represented by ca. 5% and 4%, respectively. Where facetted butts are commonly associated with Levallois technology, it should be considered that both dihedral and plain butts can figure in prepared core technology, the former usually related to flakes detached as part of core preparation and maintenance, and the latter an expression of either lack of, or indistinctive faceting.

Butt types	Frequency	Percent
Plain	97	46.2
Dihedral	16	7.6
Cortical	10	4.8
Marginal	19	9.0
Mixed	8	3.8
Facetted	30	14.3
Obscured(e.g.bydamage)	29	13.8
Retouched	1	.5
Total	**210**	**100.0**

Table 64 - Houmian complete flakes: Butt types

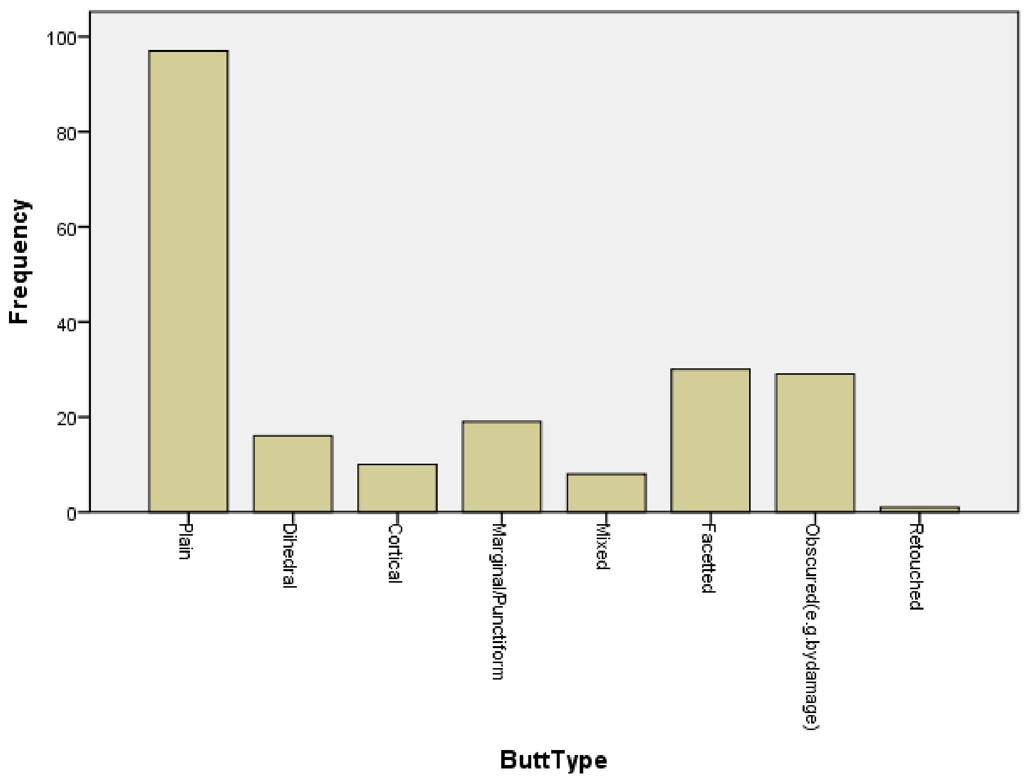

Figure 56 - Houmian complete flakes: Butt types

5.10.3.4 Distal indices of flakes

The predominant morphology for **flake termination** is the feather termination (Table 65 and Figure 57). The 11 specimens here represented as "Step(break/snap)" are not considered broken flakes, although exhibiting a similar termination, but whole flakes with edge damage. This distinction is liable to be biased, and hence subject to inter-researcher variability.

This study categorised various expressions of **pointedness** within the flake population (Table 67). This was done due to pointed tools having been claimed to be a main element in the Zagros Mousterian techno-complex (see Chapter 2). That particular category of pointed tools, however, are heavily retouched (reduced), and this study wanted to shed light on whether non-retouched points could be demonstrated to be prevalent relative to other (tool-)forms. If this could be established, an argument could be made of pointed tools in the Zagros not necessarily relating to retouch intensity or raw material exhaustion, but rather (or also) to an unrelated behavioural trait. While the majority of flakes identified as pointed were so by way of debitage or retouch, what was identified as a deliberate snap were also present. While the same issue of classification is true for this category as it was for flake termination above, unfortunately, this study failed to appreciate appropriately pointed forms on distal pieces (i.e. with missing butts), while some pointed flakes were recognised as complete and included here, and some as proximal pieces thereby excluded from analysis of pointedness.

Flake termination		Frequency	Percent
	Feather	162	77.1
	Hinge	12	5.7
	Step(break/snap)	11	5.2
	Plunging/Overshot	14	6.7
	Retouched	11	5.2
	Total	**210**	**100.0**

Table 65 - Houmian complete flakes: Flake termination

Pointed flakes		Frequency	Percent
	YesDebitage	26	12.4
	YesRetouch	16	7.6
	YesBreak/Snap	2	1.0
	No	166	79.0
	Total	**210**	**100.0**

Table 66 - Houmian complete flakes: Pointed flakes

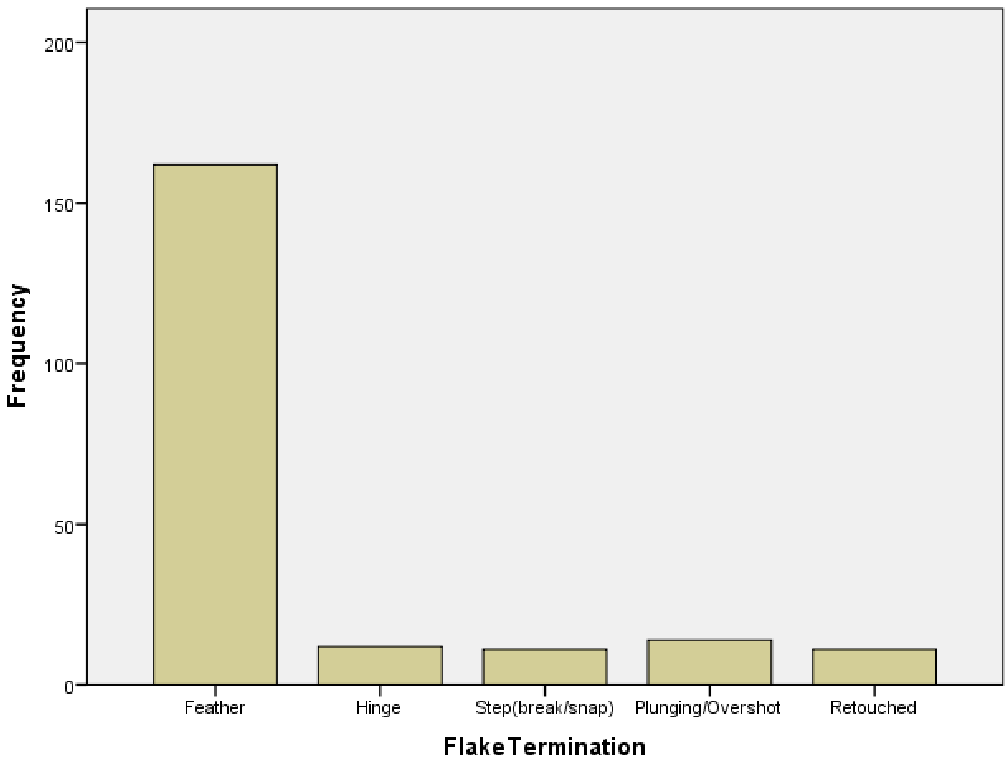

Figure 57 - Houmian complete flakes: Flake termination

Redirection flakes, exhibiting proximal ends of flake scars usually running perpendicular to the direction of the flake itself, i.e. usually from either left or right lateral, identifying the detachment of a previous flake from another direction, hence indicating core rotation, were virtually absent from the Houmian assemblage (Table 67).

Redirection flakes	Frequency	Percent
No	201	95.7
Yes	9	4.3
Total	**210**	**100.0**

Table 67 - Redirection flakes

5.10.3.5 Typology

Based on the make-up of the flake assemblage of Houmian, the material was organised into five categories in order to better reflect the techno-typological make-up of the material. All debitage (including tools and excluding nodule cores) will be analysed in five main categories of flakes (Table 68). Techno-typological descriptions of flakes such as “metrical flake”, “metrical blade”, and “metrical bladelet”, when and if occurring, will for non-Levallois debitage be included within the five main categories. The technological variability expressed with those terms (metrical flake, -blade, and -bladelet) and the relative quantities of these within the assemblage will be articulated in tables presenting metrical variables like length and width.

A flake is considered either unretouched or retouched, a tool or a multi-tool, or a core-on-flake. However, an unretouched flake can be a formal tool (e.g. a Levallois point) while a retouched flake not necessarily can be assigned a Bordesian tool type. Equally, a tool can be either retouched (e.g. a scraper), or unretouched (e.g. a Levallois point).

As such, unretouched flakes, *sensu lato*, are vastly dominating the assemblage with 88% (Table 69). Retouched flakes, *sensu lato*, comprise 12%. The ratio for retouched pieces to tools is about one to one with ca. 50% each (Table 70). Formal tool types make up only 7% of the Houmian assemblage (Table 71) (increasing to 10% if broken tools are added (Table 72). Scrapers, borers, burins, points (Levallois and Mousterian), and a notch make up the range of formal tool variability.

Data class		Frequency	Percent
	CoreOnFlake	1	.5
	RetouchedFlake	15	7.1
	UnretouchedFlake	179	85.2
	Tool	13	6.2
	Multi-Tool	2	1.0
	Total	**210**	**100.0**

Table 68 - Houmian complete flakes: All flakes and (whole) tools

Retouched	Frequency	Percent
Yes	26	12.4
No	184	87.6
Total	**210**	**100.0**

Table 69 - Houmian complete flakes: Retouched flakes to non-retouched flakes

Data class	Frequency	Percent
CoreOnFlake	1	3.2
RetouchedFlake	15	48.4
Tool	13	41.9
Multi-Tool	2	6.5
Total	**31**	**100.0**

Table 70 - Houmian retouched flakes to tools

Tool types	Frequency	Percent
Single Scraper	1	6.7
Borer/Bec/Priser	4	26.7
Levallois Point	5	33.3
Levallois Point and Notch	1	6.7
End Scraper	1	6.7
Burin	2	13.3
Mousterian Point	1	6.7
Total	**15**	**100.0**

Table 71 - Houmian tool types (whole flakes only)

Tool types	Frequency	Percent
Single Scraper	1	4.5
Borer/Bec/Priser	8	36.4
Levallois Point	6	27.3
Levallois Point and Notch	1	4.5
Convergent Scraper	1	4.5
End Scraper	1	4.5
Burin	3	13.6
Mousterian Point	1	4.5
Total	**22**	**100.0**

Table 72 - Houmian tool types (whole and broken flakes)

Each **retouched** flake had its inverse circumference measured. By inverse circumference is meant the ventral margin of a flake. This was done in order to be able to contrast the difference between total length of margins to total combined length of retouch. This result suggests that on average around 1/3 (37%) of the margins of a retouched flake has been modified (tables 73 and 74). Where possible, different episodes of retouch were identified within individual flakes. Number of retouched areas on individual flakes identified range from one to three (Table 75). Effects of length of margin and retouched area length on data class and tool type are explored in figures 48-50.

	N	Minimum	Maximum	Mean
LengthOfMargins	27	30.09	135.40	94.0267
RALength	27	4.52	99.67	35.7115

Table 73 - Length of margins and RA length: Houmian all whole retouched artefacts: including core-on-flake, retouched flakes, tools, and multi-tools.

	N	Minimum	Maximum	Mean
LengthOfMargins	15	30.09	135.40	92.1587
RALength	15	4.52	99.67	34.1147

Table 74 - Length of margins and RA length: Houmian retouched flakes only

Number of retouched areas	Frequency	Percent
1	19	73.1
2	5	19.2
3	2	7.7
Total	**26**	**100.0**

Table 75 - Houmian flakes by number of Retouched Areas (RA)

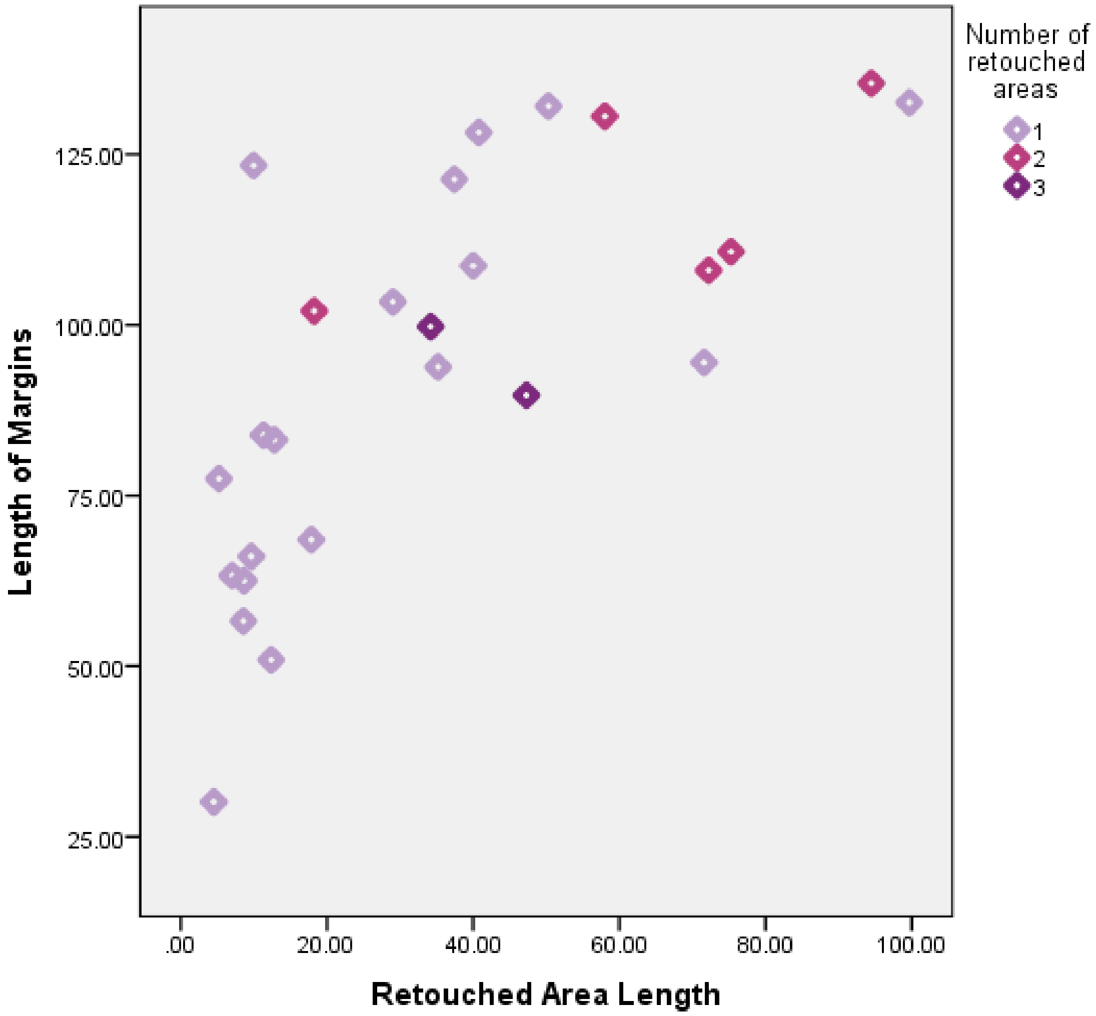

Figure 58 - Houmian flakes by number of retouched areas

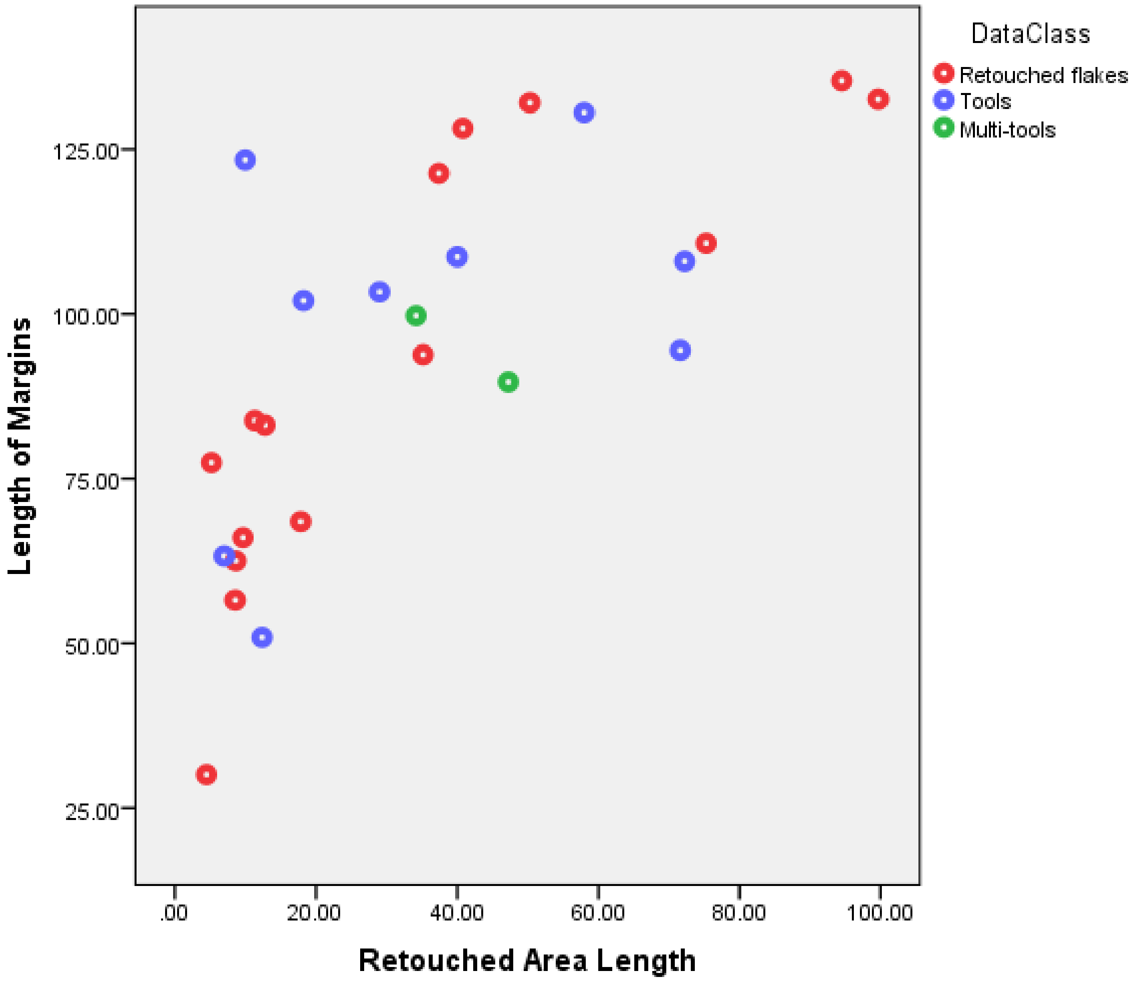

Figure 59 - Houmian data class for retouched pieces by length of margins/RA length

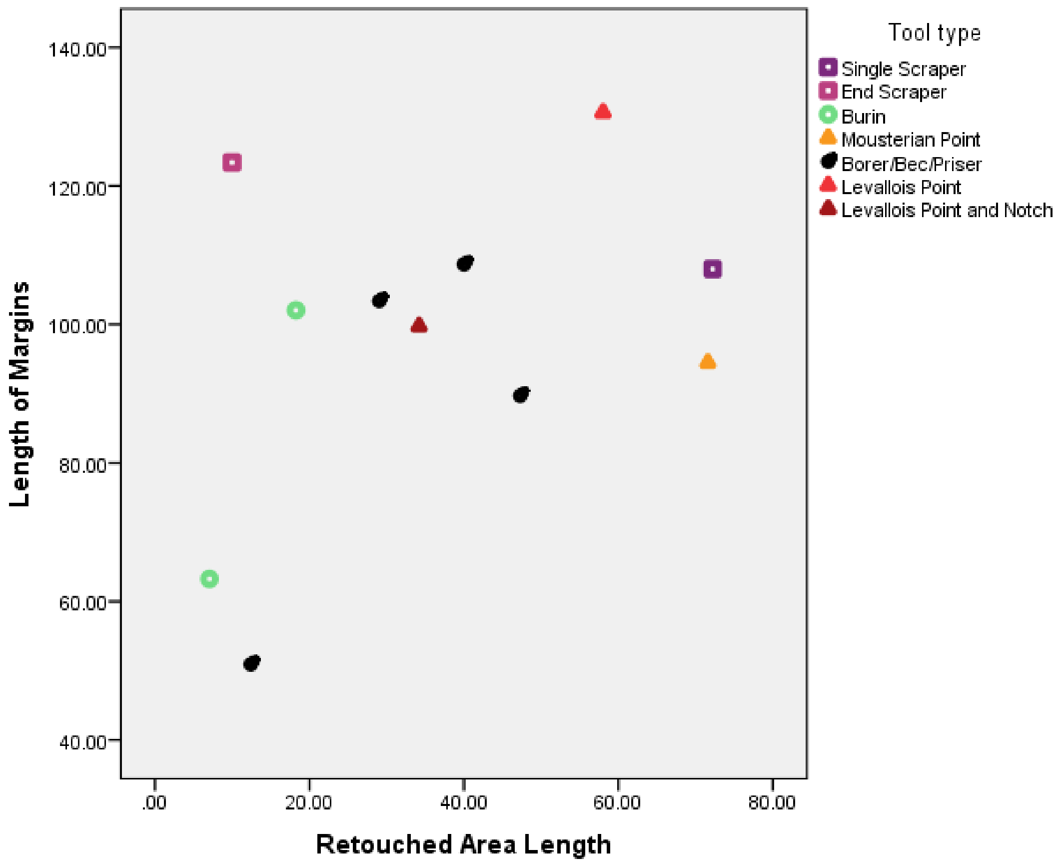

Figure 60 - Tool types

5.10.3.6 Levallois

Turning to the Levallois component of the Houmian flake assemblage, we find that techno-typological Levallois pieces forms exactly 10% of the whole-flake population, and covers all non-core data classes (Table 76). Of the 21 pieces, ca. 40% are flakes, ca. 30% points, and ca. 20% blades (or rather metrical blades) (Table 77). Around half of the Levallois pieces preserve evidence of a previous piece detached prior to the last preferential detachment, and about 30% seems to be results of lineal exploitation (Table 78). Mode of preparation is mainly uni- or bi-directional (or unipolar and bipolar) if not indeterminate (Table 79). Mode of exploitation is mainly unidirectional recurrent or lineal (Table 80). No definite evidence for repreparation were identified on the dorsal surface of the flakes, although this might pertain to the difficulty in differentiating between episodes of preparation (Table 81).

Data class	Frequency	Percent
Core on flake	1	4.8
Retouched flake	5	23.8
Unretouched flake	6	28.6
Tool	8	38.1
Multi-tool	1	4.8
Total	**21**	**100.0**

Table 76 - Houmian Levallois flakes by data class

Type of Levallois product	Frequency	Percent
Flake	8	38.1
Blade	4	19.0
Point	7	33.3
Core-on-flake	1	4.8
indeterminate	1	4.8
Total	**21**	**100.0**

Table 77 - Houmian Levallois flakes by type of Levallois product in morphological terms

Preceding Levallois removals	Frequency
0	7
1	11
2	2
Total	**20**

Table 78 - Houmian Levallois flakes by number of preceding Levallois removals

Mode of preparation	Frequency	Percent
Core-on-flake	1	4.8
Unipolar	9	42.9
Bipolar	4	19.0
Centripetal	1	4.8
Indeterminate	6	28.6
Total	**21**	**100.0**

Table 79 - Houmian Levallois flakes by mode of preparation

Mode of exploitation	Frequency	Percent
Core-on-flake	1	4.8
Lineal	7	33.3
UnipolarRecurrent	10	47.6
BipolarRecurrent	3	14.3
Total	**21**	**100.0**

Table 80 - Houmian Levallois flakes by mode of exploitation

Evidence of repreparation	Frequency	Percent
Core-on-flake	1	4.8
No	20	95.2
Total	**21**	**100.0**

Table 81 - Houmian Levallois flakes by evidence of repreparation

5.11 Discussion of the Houmian Layer 2a assemblage

The Houmian lithic assemblage has only been published once before by Bewley (1984), a student of the excavator, McBurney. Bewley's study has since been cited as evidence that the assemblage adheres to techno-typological indices associating it to the Zagros Mousterian techno-complex. Bewley (1979, 1984: 35), however, was hesitant in passing final judgement, never quite allowing a clear association of Houmian with the Zagros Mousterian, and the data analysis presented above really is the first study to test the material in the backdrop of the expanded literature on the subject over the last four decades.

As explained previously, a focus on the lithic assemblage from Layer 2a only was the obvious decision, as this layer was by far the largest sample. Further, the pollen analysis had identified Layer 2a as situated within an interstadial, which might help in a behavioural interpretation of the deposit. Finally, Houmian had an un-curated lithic assemblage, meaning all lithic material had been kept by the excavator, and the material therefore did not suffer a skewed assemblage composition like the assemblages of other Zagros sites.

5.11.1 Raw material sourcing and taphonomy

Lithic raw material exhibits large variation in colour, similar to that found at Shanidar and Warwasi.

A possible indication of link between cores and flakes is through identification of remnant cortex. Whether an artefact can be said to be made on raw material obtained either directly from its source of outcrop, or on a secondarily available nodule, like such found within river gravel, is attested by remnant cortex. Fresh, unrolled cortex is normally thick and chalky, where rolled cortex will appear thinner and show signs of clast collision in the form of battering (e.g. Shaw 2012: 203). According to White (1998) it is possible to source flint/chert if a given artefact retains evidence of fresh, unrolled cortex.

All cortex identified on the Houmian flakes and cores have been rolled, suggesting that the raw material, in the form of cores, came from a secondary source, like river gravel, and not from a primary outcrop.

Since no raw material studies from the relevant areas of the Zagros Mountains were available to this author, and none could be carried out, raw material sourcing as a way of addressing hominin raw material provisioning/gathering, in order to address hominin mobility was not employed or incorporated as a proxy or heuristic tool. Indeed, the multifaceted, though mainly chert-based, raw material variability present in the various assemblages studied in this thesis suggest that dedicated petrological analyses is a necessity if usable inferences were to be extrapolated based on raw material type and affinity. Dedicated petrological analyses were beyond the scope of this research. As any type of flint, chert, calcedony, etc. might have been available at different times through the bedload of rivers, e.g. the Greater Zab in the case of Shanidar Cave, it seems to this author futile to speculate about their original source.

5.11.2 Core to flake correlation, on-site core reduction, and flake modification

Looking at the correlation between flakes and core mean size, it would appear there is basis for assuming a technological relationship between these two parts of the Houmian assemblage. As complete flakes have a mean length and width of 28 mm and 19 mm respectively, and the stratified combined core assemblage for their part have mean dimensions of 40 mm and 33 mm for length and width, and a mean size of largest flake scar of 30.5 mm and 18.5 mm, respectively, it is possible to correlate flake length and width with flake scars on cores. Since the mean length and width of flakes and scars on cores are congruent it would serve to suggest that the flakes, at least in theory, could have been detached from the core assemblage.

Core rejuvenation, or core trimming, expressed by what is here called redirection flakes, is relatively low (ca. 3% of flake population), and should possibly be interpreted as indication of low on-site core reduction. However, on-site knapping not specifically involving core reduction, like e.g. flake detachments from core-on-flakes (less likely to produce redirection flakes), tool maintenance, or knapping activities not involving core platform transposition, could still have been prevalent.

Together with the information available for comparative sites, and from studies of hunter-gatherer provisioning strategies, and research on raw material exploitation and constraints, it would be reasonable to assume that cores reaching Houmian would already have been considerably reduced or even depleted. In such case, size comparisons between flakes and cores might not be desirable or even possible. However, since there does exist a positive correlation between cores and flakes, the assumption here is that this factor is significant enough to assume a behavioural signature, i.e. that at least final stage core reduction, and certainly flake modification was practised by hominins at Houmian.

5.11.3 Retouch intensity

It was expected that retouch intensity among the Houmian flakes and tools, Houmian being alleged to be a Zagros Mousterian assemblage, were similar to fellow Zagros sites like Shanidar and Warwasi, and higher than among flakes and tools from Levantine Mousterian contexts, e.g. Ksar Akil. This has not been corroborated by this analysis. Instead, only around 10% of the Houmian flake assemblage is retouched. When examining this retouch, only 4% can be classified as having the extent- ("invasive"), and only 1% the morphology ("stepped") of retouch, necessary for an overall characterisation as Zagros Mousterian, as described in the literature (e.g. Dibble 1991; Lindly 1997; Shea 2013).

It was expected that tools like scrapers would be heavily retouched and show a propensity for "Quina retouch", i.e. the Mousterian variant with invasive, abrupt, stepped retouch. Again, this is not corroborated in the Houmian flake and tool assemblage.

5.11.3 Technology and typology

The tool typology for Houmian, Layer 2a, is roughly divided between 33% Levallois points, 33% pointed tools like borers and becs, with the last 33% split between scrapers and burins. As already mentioned, very few of these tools display the amount of retouch modification necessary for a traditional attribution into the Zagros Mousterian.

5.11.4 Evidence for Levallois technology and reduction at Houmian

With only two true Levallois cores in the Houmian assemblage, and only six simple prepared cores, and in total just ca. 8% of the core and flake assemblage being identified as Levallois, discussions related to the use of this reduction technique in the context of the site of Houmian will remain somewhat tentative. One thing that can be argued is the possibility that the lack of Levallois at Houmian, and more generally other sites related to the Zagros Mousterian, can be attributed not only to supposed raw material scarcity, but also to small size of this raw material at stage of discard on site. The small size of the discarded simple prepared cores makes it difficult to demonstrate whether these have been exploited as true Levallois cores earlier in their reduction sequence, and have since been reduced through alternate flaking, creating either quasi- or techno-typological discoidal cores, or even through *ad hoc* reduction likewise erasing the traits necessary for true Levallois identification. Although only two cores in Layer 2a can be said to be true discoidal cores, a significant proportion of cores in the assemblage show discoidal reduction sequences as the primary (last) reduction sequence before discard.

Consequently, information about Levallois core reduction strategies, i.e. to what extent prepared core technology was utilised, is limited. Further, we must remember that with Levallois reduction much debitage from the process of preparing the detachment of a preferential (Levallois) end product, technologically or indeed typologically cannot be distinguished from non-Levallois debitage.

5.11.4 Major insights to hominin behaviour at Houmian based on data analysis

Analysis of the Houmian Layer 2a assemblage has revealed that overall this material does not conform to the expected pattern of techno-typological characteristics expected for a Middle Palaeolithic site in the Zagros Mountains: Neither generally, as part of the so-called "Zagros Mousterian" techno-complex; or specifically (as part of the so-called "Zagros Mousterian" techno-complex) *within* its particular high altitude setting of 2000 m a.s.l.

It was expected that Houmian not only would exhibit traits conforming to the Zagros Mousterian techno-complex, i.e. extensive retouch, relative abundance of pointed and heavily retouched tools, comparatively short and non-laminar debitage, recurrent discoidal core preparation and a focus on truncated-faceted-cores and cores-on-flakes, but also feature altitude-specific technological signatures such as a significant truncated-faceted pieces and/or core-on-flakes ratio to centripetal cores as proposed by Lindly (1997:264). While the debitage can be said to be 82% non-laminar, Houmian shows a lack of pointed and heavily retouched tools, does not exhibit a relative abundance of Mousterian points and scrapers, and have only three cores-on-flakes and no truncated-faceted pieces. The paucity of the latter trait is especially problematic for an association of Houmian as part of a latter-stage, vertical mobility strategy, illustrating high altitude reduction through the presence of truncated-facetted pieces and/or core-on-flakes.

This would seem to challenge the specific narrative of lithic technological decision-making and raw material exploitation, based on vertical mobility in the Zagros Mountains, identified in the Zagros Mousterian as proposed by Lindly (1997).

5.12 Summary of discussion of Houmian Layer 2a data analysis

Raw material sourcing

- Dedicated raw material sourcing was not carried out. Assumption is that raw material most likely was sourced from local river beds, river terraces, or *én route* to the site.

Core to flake correlation, on-site core reduction, and flake modification

- Core sizes and flake sizes (including *largest flake scar on core*) lend support to on-site reduction.

Retouch intensity

- Houmian does not support Skinner (1965), Lindly (1997), Dibble (1991) evidence of "heavy retouch", "Quina retouch", "steep retouch" on scrapers or pointed tools.

Technology and typology

- Houmian does **not** support Lindly's (1997) hypothesis about "altitude-determined reduction stages", specified in ratio of "centripetal cores" to "truncated-facetted cores" (truncated-facetted pieces and core-on-flakes), i.e. a switch from high numbers of centripetal cores in lower altitude site assemblages to high numbers of core-on-flakes in higher altitude site assemblages.
    - Only three core-on-flakes occur in the assemblage -equivalent of 0.8% of flakes or 0.7% of total assemblage.

Evidence for Levallois technology and reduction at Houmian

- "Knowledge of"/"use of" Levallois is present at Houmian (i.e. either on-site Levallois reduction, or at least part of Levallois *Chaîne opératoire* at Houmian, e.g. discard of exhausted Levallois cores and tools).
    - Small/exhausted cores could have been brought in/discarded at Houmian.
    - Levallois points are present in relatively prominent numbers.

Major insights to hominin behaviour at Houmian based on data analysis

- Houmian Layer 2a assemblage cannot be termed Zagros Mousterian
    - Does not show enough typical techno-typological traits
        - lack of pointed and heavily retouched tools
    - Does not show expected altitude-specific traits
        - Few core-on-flakes (no truncated-facetted pieces)
- Pollen analysis contextualised with the Layer 2a lithics suggest the assemblage was deposited *not* within a warm phase, but within a colder phase

- This would serve to challenge the "Zagros Mousterian summer adaptation model" proposed by Lindly (1997)

Chapter 6 - Shanidar Data Analysis

6.1 Curatorial history and size of Layer D collection

The Shanidar lithics assemblage was divided between the Iraqi authorities and the excavator, as practice was at the time. Uncertainties remain as to exactly how much material was brought to the US, how much was left in Baghdad, and how much – if any – was discarded at the site. According to the excavators (Solecki and Solecki 1993: 119), "*the greater part of the collection is in Baghdad*", more specifically the Iraq Museum (the National Museum of Iraq) in Baghdad. The assemblage curated in the US were at some point (immediately?) divided between Columbia University in New York, where Ralph Solecki was professor of anthropology, and the Smithsonian Institution in Washington, DC, who co-sponsored the excavation. The part of the assemblage curated at Columbia was permanently transferred to the Smithsonian Institution in 2017, and was not available for study for this thesis.

The exact number of Layer D (Middle Palaeolithic) lithics recovered by Solecki during the original excavations is unknown to this author, but a few published notes help making an estimate possible. Solecki comments about the status of the lithic assemblage after the two first seasons of fieldwork:

> "*The number of flints recovered during the 1951 and 1953 seasons total approximately 2,800 specimens. Of this number, over 40 percent are use-retouched flakes and blades, notched blades and flakes, cores and core fragments. Layer B in the stratigraphy yielded the most flints for its shallow deposit, numbering well over 1,000 specimens. Of the remainder,* ***Layer D*** *yielded the next in numerical proportion, while Layer C produced the least number of specimens*" (Solecki 1955: 408. Emphasis mine) (Figure 61).

James Skinner (1965) was the first to systematically study the material from Layer D in detail. His PhD dissertation included 618 artefacts from all three assemblages (Columbia University and the Smithsonian in the US, and the Iraq Museum in Baghdad). Of these, 571 are (Bordes-type) tools and 47 are cores. Unfortunately, he does not specify which parts of the material analysed comes from which collection and does not include a count of the non-tool/non-core assemblage, e.g. unretouched flakes and chunks/chips, i.e. the material left out of his analysis.

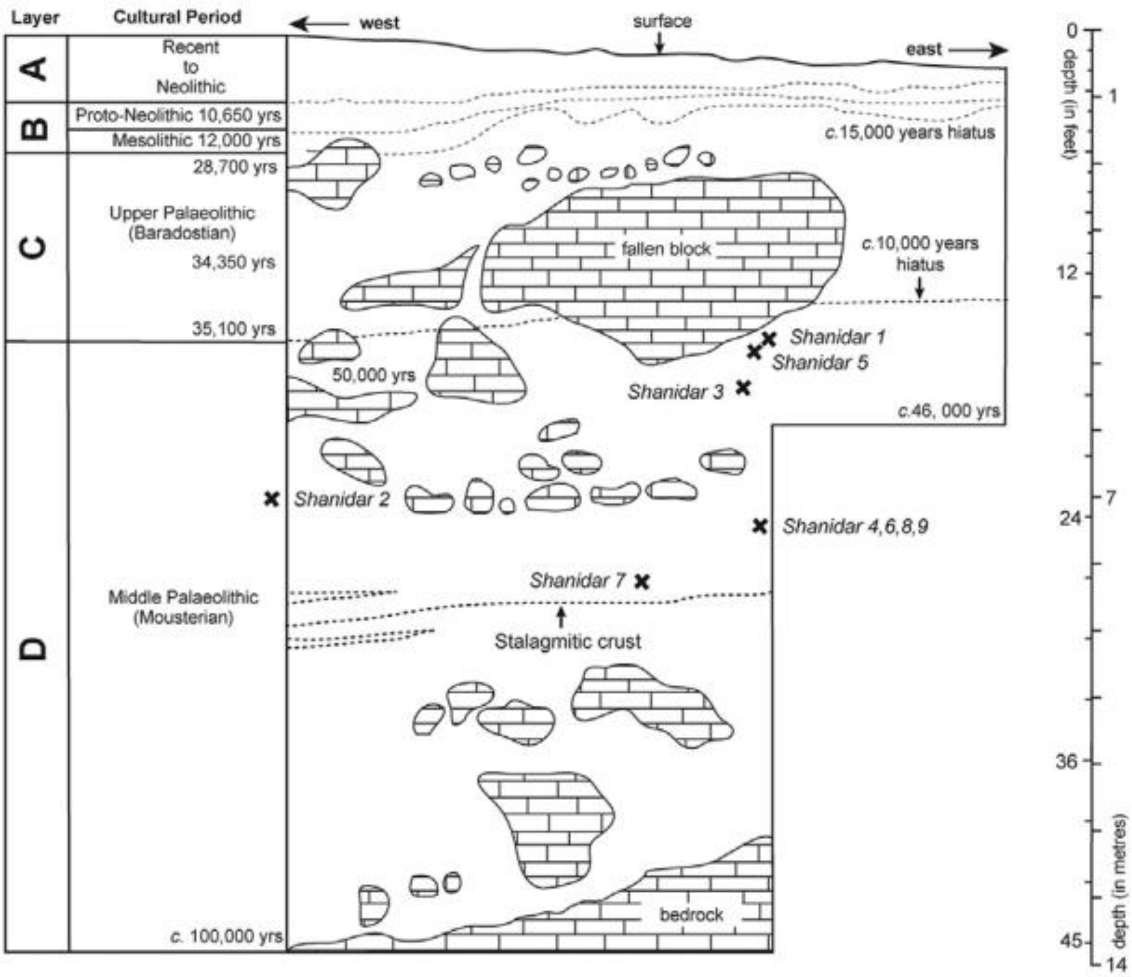

Figure 61 - Schematic overview of Solecki's excavation (after Pomeroy et al. 2017:103, adapted after Solecki 1963:183)

In 1975, **Takeru Akazawa** publishes a study on the Shanidar assemblage in the Baghdad collection. He states that:

> "*A total of some 1000 specimens were examined, being the total material from Layer D deposited in the Iraq Museum in Baghdad, after the division of the collection between the Museum and the excavator*" (Akazawa 1975: 4).

In a note he details:

> "*A large quantity of material from the Shanidar Cave was deposited in U.S.A., after the division of the collection between the Iraq Museum and the excavator. Among them, Skinner (Columbia University) has examined and reported 571 implements and 47 cores* [from] *Layer D, in Columbia University and the United States National Museum, Smithsonian Institution (Skinner 1965: 103-105)*" (Akazawa 1975: 4).

Akazawa goes on to specify what appears to be the most reliable count of the Shanidar Layer D lithic assemblage in Baghdad, 1053 artefacts total:

> "*The material of Layer D assemblage falls into four categories on the basis of their techno-typological characteristics, consisting of implements (714 pieces), fragments of implements (63), cores and core fragments (130) and waste pieces including core rejuvenation flakes (146)*".

Akazawa further elaborates on the layer D sub-assemblage of non-tool debitage:

> "*The last category are unretouched pieces, being unclassifiable into the other categories described above, making up about 14 percent. These consist of broken pieces, core rejuvenation flakes, and other waste pieces and chips produced during the preparation of cores and blanks*" (Akazawa 1975: 5).

Part (or all) of the assemblage in the Smithsonian that I analysed for this thesis, had been on loan to Texas A&M University, presumably when the Solecki's were there in the early 1990s (Solecki 1992). Accordingly, on some of the archival cards it was stated this material had been returned from loan to the Smithsonian. The 172 Layer D pieces analysed in this present thesis are from the material of 220 pieces I was able to access at the Smithsonian in March 2017. The Columbia assemblage had only just been transferred to the Smithsonian and was inaccessible to me as it had not yet been accessioned. Unfortunately, this, to me unavailable, assemblage likely included the main portion of the US-based part of the collection of types of what Solecki and Solecki (1993) termed the "Shanidar pointed tools", which comprised retouched points, Mousterian points, convergent scrapers, etc. Without this known absence of a crucial signature of the Shanidar Middle Palaeolithic assemblage, obviously inferences pertaining to ratios of retouched tools vs retouched and unretouched flakes cannot be directly addressed. Further, having only three cores available is not ideal for the analysis.

6.2 Previous studies of the Shanidar lithics

James Skinner's seminal work (1965) on the Zagros Mousterian included an analysis of 571 tools and 47 cores (618 total) selected from both the US and Baghdad Shanidar collections (Skinner 1965: 104, Solecki and Solecki 1993: 123; but see Akazawa (1975: 4) who seems to allege Skinner's study did not include the Iraqi material). While Skinner provides a list of Bordes-types for the tools, what is more interesting to me is the mentioning of the cores, if only as a side note, since my study sample consists of just 3. Skinner defines his core sample as 27 discoidal, 10 prismatic and 10 "informe" (which presumably is to be understood as amorphous, i.e. cores with multiple unrelated or opportunistic platforms – what in this present study is referred to as "migrating" platform cores).

Understanding and definition of Levallois technology at the middle of the 20th Century were understandably not as developed as today (e.g. Dibble and Bar-Yosef 1995). The Bordes (1961) type list today, although seminal, is considered increasingly outdated for behavioural inference, although still crucial as a lingua franca (e.g. Debénath and Dibble 1993; Shea 2013). Accordingly, I will not engage with Skinner's typological organisation of flake tools (Skinner 1965: 104), as our separate ways of identifying techno-typological affinities will at best serve to confuse, and at worst cloak interpretive disagreements in a vail of false semblance.

Akazawa's (1975) preliminary study of the part of the Shanidar Layer D collection housed in Baghdad focused on 714 "implements", or tools. However, contrary to Skinner, he describes the non-tool assemblage as well, and identifies and acknowledges groups of both unretouched (naturally backed knives) and retouched pieces as potentially showing sign of use, evidenced by various patterns of edge modification. He calls this "*more or less traces of edge retouch from secondary use*" (1975: 7).

His study also includes 130 cores and core fragments, but does not, unfortunately, specify how many of those are cores and how many are fragments. While these cores and fragments initially are described as "*somewhat variable in form*" (1975: 4), Akazawa continues to offer a seemingly unnecessary further description:

> "*but they share the same characteristic feature; all of them have more or less flaking scars on their surfaces, suggesting the removal of blanks on which implements are made*" (Akazawa 1975: 4).

To me, this description seems a little excessive, as, surely, the reader is well aware of the techno-typological "concept" of a core without Akazawa having to explain it? While not entirely a superfluous paragraph, what strikes me is the possibility that Akazawa might actually be describing Levallois technology: Talking about how the cores share the same *characteristic feature* of flaking scars on their *surfaces*, *suggesting the removal of blanks on which implements are made* could, in my opinion, be descriptive of a Levallois flake release surface. While this is arguably an over-interpretation of Akazawa's words, and while it would remain to be explained why he would not have explicitly mentioned the existence of Levallois cores in the Baghdad assemblage, that they *are* present within the Shanidar Layer D assemblage is confirmed by the excavator, as we shall see below.

Ralph Solecki and **Rose Solecki**'s most in depth study of the Middle Palaeolithic lithic assemblage from Shanidar (Solecki and Solecki 1993) centres on an attribute analysis of 798 retouched tools – the so-called *pointed tools* – of the Shanidar Layer D deposit. 678 of these were from the main collection in Baghdad, and 120 is said to be from the US. It is unclear whether the US material referred to is a single collection or from multiple institutions. As noted above, the material in the Smithsonian seems to have been on loan to Texas A&M University at the same time as the Solecki's were there. Given this, it seems reasonable to assume parts of that material could be included in their study. However, as mentioned earlier, very few “pointed tools” are included in the (pre-Colombia collection-merger) Smithsonian collection of 220 assorted pieces, I was able to access in early 2017.

Although Solecki and Solecki (1993) detail their methodology and rigorously define the various tool types within their Shanidar Layer D material, even including data such as measurements and statistics, which cannot always be expected to be a staple of published accounts of lithics, I am still reluctant to incorporate their results into my analysis. Firstly, Solecki and Solecki only include retouched tools in their analysis. Secondly, they only include retouched tools deemed to be “pointed”. Thirdly, while their study certainly contributes valuable technological attribute data, it is my opinion that the attribute data is grounded in a typological narrative I cannot subscribe to. This effectively, and very unfortunately, renders their published metric data unusable for my study.

However, Solecki and Solecki’s central points concerning the pointed tools are significant and valuable in themselves. Their reasoning for conducting this study was due to pointed tools representing the most common retouched artefact category in the Layer D deposit, stating:

> “*we decided to study all of these tools as a group because of their most obvious feature, a converging pointed end*” (Solecki and Solecki 1993: 128).

They divided the assemblage of pointed retouched tools into distributions of “pointed tool types” and “point types”. They carried out an analysis of the different butt types and identify what they described as “post-removal butt modification”. This was identified as various types of thinning, faceting, and/or retouch. This modification seemed to correlate with their “small-sized (Bordes-) Type 6 Mousterian point. They find that post-removal butt modification is:

> “*almost twice as common in the tools* [they] *classified as points than in the other pointed-ended tools*” (Solecki and Solecki 1993: 128).

This, they argued, could be related to points being hafted as projectile armatures. Based on their study, Solecki and Solecki (1993: 128) suggest that:

"*the Neandertals purposefully made points with specific functions in mind, although they could and probably did use them for other purposes as well*".

However, they are aware of the possibility the various typological types and subtypes identified in their sample is caused by continuing retouch and/or resharpening sequences propelled by continued use, rejuvenation, and re-use (Solecki and Solecki 1993), as proposed by Dibble (e.g. Dibble 1987).

The question of the extent of employment of Levallois technology at Shanidar Layer D in general, and the existence of Levallois cores in particular, is crucial. It is crucial because the existence of Levallois cores at Shanidar would be a strong argument for the claim that prepared core reduction was being carried out within the cave locale, as opposed to Levallois blanks, or tools made on Levallois blanks, being transported into the cave from an off-site production area. This is important for discussions of use of lithic raw material, land-use, and strategic mobility.

Solecki, in an early overview article in Science, a few years after the last field season, claimed that:

"*No **Levallois** prepared cores were found…*" (Solecki 1963: 188. Emphasis mine).

This assessment was changed about a decade later when his popular book on the Shanidar excavations were published:

"*That the Zagros Neanderthals knew the **Levallois** technique of extracting flakes from tortoise cores is evident at Shanidar. This is exemplified by the four or five diminutive Levallois cores made on small pebbles. The rest of the cores are of the so-called "residual" type, mere nubbins, with numerous flake facets. The toolmaker had struck every last bit of usable material off the core before finally discarding it*" (Solecki 1971: 264. Emphasis mine).

In his 1997 re-examination of the Zagros Mousterian, **John Lindly** (1997:256) comments on Solecki's above mentioning of the presence of Levallois and non-Levallois cores:

> *'four or five diminutive Levallois cores', with the remaining cores being 'a 'residual' type (probably including longitudinal, centripetal*[,(?)] *and amorphous types*".

Unfortunately, Lindly himself neglects to describe the one core in his assemblage. It would have been valuable having known if this was Levallois or not. Like the Solecki's 1993 publication, Lindly's study was based on material from Texas A&M University, but only included a total of 176 pieces (121 whole flakes, 54 tools and 1 core, although that number is 170 in a summary table (1997: 348)), which seems very close in overall quantity to resemble the Smithsonian assemblage this present study is based on.

6.3 Sampling method and assemblage composition of the lithics

This study includes 172 lithics from stratified contexts within the Shanidar Layer D assemblage. The material used in this study is from the assemblage housed in the Smithsonian (see Appendix plates 11-20). Within my 172-piece study sample, one flake is unassigned to a specific cut, and three flakes are not attributed to a specific spit. Consequently, these four pieces have been excluded from analyses, leaving the functional sample at 168. "New" material from the current re-excavation of Shanidar, in the form of lithics or environmental proxies, were not available for this thesis.

Like the material from Houmian, this is a core and flake assemblage. Only three cores were available and are included with 165 flakes. Of the flakes, seven are classified as core-on-flakes. Retouched flakes constitute 23.2% alongside 17.9% tools. Unretouched flakes make up just over 51.8% of the assemblage (Table 82).

Data class	Frequency	Percent
Core	3	1.8
CoreOnFlake	7	4.2
RetouchedFlake	39	23.2
UnretouchedFlake	87	51.8
Tool	30	17.9
Multi-Tool	2	1.2
Total	168	100.0

Table 82 - Shanidar Layer D lithic assemblage by data class

Tables 83-85 presents an overview of the distribution of the sample lithic sample by cut, layer, and spit, respectively. The 168 pieces available for this analysis represent material recovered from ten different squares (here called cuts) (figures 62 and 63).

Cut	Frequency	Percent
A-7	3	1.8
A-9	1	.6
B-7	8	4.8
B-9	2	1.2
C-10	1	.6
C-7	1	.6
C-8	34	20.2
C-9	9	5.4
D-7	80	47.6
D-8	29	17.3
Total	168	100.0

Table 83 - Shanidar Layer D lithics by cut

Layer	Frequency	Percent
D	168	100.0

Table 84 - Shanidar Layer D lithics by layer

Depth	Frequency	Percent
4.00-4.25	1	.6
4.25-4.50	2	1.2
4.45	1	.6
5.40	2	1.2
5.50-5.75	1	.6
5.75-6.00	3	1.8
6.25-6.50	1	.6
6.75-7.00	14	8.3
7.00-7.25	24	14.3
7.20-7.75	21	12.5
7.25-7.50	1	.6
7.50-7.75	20	11.9
7.75-8.00	15	8.9
8.00-8.25	7	4.2
8.25-8.50	36	21.4
8.75-9.00	19	11.3
Total	168	100.0

Table 85 - Shanidar Layer D lithics by spit

6.3.1 Thermal alteration and Recycling

Thermal alteration is found on just four lithics, interestingly, only in cut D-7 (Table 86). Three of these are found within relatively close proximity. Three pieces showed evidence of having been recycled (Table 87). Of these, two are from the same spit in cut C-8.

Depth	Frequency	Percent
7.00-7.25	1	25.0
8.25-8.50	1	25.0
8.75-9.00	2	50.0
Total	4	100.0

Table 86 - Thermal alteration of Shanidar Layer D lithics

			Cut
		C-8	D-8
	Depth	Count	Count
Spit	7.20-7.75	2	0
	8.25-8.50	0	1

Table 87 - Recycled pieces, Shanidar Layer D

6.3.2 Taphonomic assessment

Although a dedicated taphonomic study could not be carried out due to explicit rules on handling of lithics imposed by the institution wherein the material is housed, a broad visual appreciation determined the 172 pieces to be of sufficiently similar physical condition, without parts of the assemblage showing signs of more or less post-depositional alteration than other parts. This opened up for treating the Shanidar Layer D material as one broad assemblage, albeit stratigraphically divided between various diachronic contexts between discrete cuts and spits.

6.4 Cores

6.4.1 Core assemblage size by cut and spit

This study, unfortunately, only had access to three cores (Table 88). These three cores are all from different, although adjoining, cuts (Figure 62). Interestingly, however, they are from the same 25 cm spit level of 7.00-7.25 meters within Layer D4a below datum. This circumstance, together with the relative proximity of the three cuts (B-7, C-8, D-7), could warrant the assumption that these three cores pertain to the same archaeological context or horizon, thereby allowing them to be treated collectively. Accordingly, they will be analysed as a group.

6.4.2 Core raw material and blank form

The cores are all from different **colour flint or chert**, ranging between dark brown, light grey, and purple. One of the cores can be identified as a **nodule**, but none of the cores **retain original blank form**.

6.4.3 Unprepared core size

The length, width, and thickness of the three unprepared cores are presented in tables 89-90. They are all quite similar in size with mean dimensions of length, width, and thickness of 30 mm, 24 mm, and 22 mm, respectively.

				Cut
		B-7	C-8	D-7
		Count	Count	Count
Spit	7.00-7.25	1	1	1

Table 88 - Shanidar Layer D cores by cut and spit

Cut	MaxLength	MaxWidth	MaxThickness
B-7	34.04	22.31	19.30
C-8	29.37	29.59	28.96
D-7	26.16	20.13	18.11

Table 89 - Shanidar Layer D cores by max length, max width, and max thickness

	N	Minimum	Maximum	Mean
MaxLength	3	26.16	34.04	29.8567
MaxWidth	3	20.13	29.59	24.0100
MaxThickness	3	18.11	28.96	22.1233

Table 90 - Shanidar Layer D cores by descriptive statistics

Looking at core reduction method and intensity, two techniques are immediately observable. All three cores are **unprepared** with two characterised as migrating platform cores and one being **discoidal** (Table 91). The two migrating cores have multiple core episodes with few removals per episode, whereas the discoidal core displays a single core episode comprising a large number of removals (Table 92). Mean dimensions of largest scar length and width are both 15 mm (tables 93-94).

Core reduction method	Frequency	Percent
Discoidal	1	33.3
MigratingPlatform	2	66.7
Total	3	100.0

Table 91 - Characterization of overall core reduction method, Shanidar Layer D

	No. of Core Episodes	No. Flake Removals per Core Episode 1	No. Flake Removals per Core Episode 2	No. of Flake Removals per Core Episode 3	No. of Flake Removals per Core Episode 4	Total no. of Removals
A426450	1	14	.	.	.	14
A426461	4	3	1	2	4	10
A426467	4	1	1	1	2	55

Table 92 - Shanidar Layer D cores by total number of core episodes, number of removals per core episode, and total number of removals.

	Size of Largest Scar Length	Size of Largest Scar Width
A426450	9.12	14.22
A426461	16.36	19.55
A426467	19.28	10.40

Table 93 - Size of largest scar length and width, Shanidar Layer D

	N	Minimum	Maximum	Mean
Size of Largest Scar Length	3	9.12	19.28	14.9200
Size of Largest Scar Width	3	10.40	19.55	14.7233

Table 94 - Size of largest scar length and width: descriptive statistics, Shanidar Layer D

6.5 Unprepared core technology and reduction

6.5.1 Overall core reduction method for unprepared cores

Two of the three cores have remnant cortex, suggesting a less than exhaustive exploitation of the core blanks. This is guided by the assumption that lack of cortex retention is proportional to, or is a factor in, core discard. Alternatively, these cores were discarded when preferred debitage size exceeded the remaining core blank volume (Table 95). Seven core-on-flakes are identified in the Shanidar assemblage, and will be described with the flakes below.

Cortex retention on surface area	Frequency	Percent
0%	1	33.3
>25-50%	2	66.7
Total	**3**	**100.0**

Table 95 - Cortex retention on surface area of core, Shanidar Layer D

6.6 Flakes

6.6.1 Flake assemblage size by cut and spit

This analysis will follow the outline of the examination in Chapter 5 of the Houmian flake assemblage. As has been illuminated above, there are several ways to divide up the available Shanidar lithic assemblage for the purpose of gaining insights into the behavioural dynamics of the hominins occupying the cave. As treating all the available 165 Layer D flakes as one assemblage indiscriminate of their internal stratigraphic geo-chronology would certainly be futile for anything but the crudest of assessments, three alternative levels of resolution have been identified in this study. Following Solecki and Solecki's (1993) most recent discussion of the Mousterian stratigraphy, in where they argue for a subdivision of Layer D into seven distinct horizons (layers D1-D7, uppermost to lowermost), I will focus my analysis on what they have identified as the most behaviourally important part of Layer D, Layer D4. Solecki and Solecki (1993: 121) further subdivides Layer D4 into three separate horizons, named D4a, D4b, and D4c. It is within this imposed boundary of 165 stratified flakes (available for this study through the Smithsonian), unevenly divided over five meters (4.00 - 9.00) of deposit, unevenly distributed within a cluster of ten adjacent cuts, that we have to tease out technological insights. In an effort to increase the behavioural signature of the available flake assemblage, and to reduce the potential of interpretive error due to speculative amalgamation of sampling units, this study will focus exclusively on the available material from the three sub-divisions of Layer D4. Consequently, while an exact appreciation of the precise volume of deposit across each of the individual cuts (bearing lithics or not) have not been available to me (Solecki and Solecki 1993: 120-123), it is still possible to appreciate the considerable reduction in volume of deposit between the conceptual units S10 through S2 (see below). From an estimated 200m^3 (40m^2 horizontally by five meters (4.00 – 9.00) vertically)) in Unit S10, to 16m^3 (8m^2 horizontally by two meters (7.00 - 9.00) vertically)) in Unit S2. This equates to a reduction in deposit of 92%, but only a loss in lithic material of 15% (25 of 165 pieces).

6.6.2 Heuristic units

Unit S10

The conceptual Unit S10 includes all the ten cuts within Layer D from where lithics for this study have been available (Figure 62 and table 96). As such, Unit S10 contain deposits extending from the termination of the Mousterian horizon (Layer D1) at around a depth of 4.00 meters below datum, until a depth of 9.00 meters, which equates to two thirds of sub-layers D4a, D4b, and D4c (7.00 - 10.00 m), i.e. D4a (7.00 – 8.10 m), D4b (8.10 – 8.70 m), and D4c (8.75-9.00 m). As such, the last 1 m of D4c deposit is not represented, as no lithics were available.

Lithic material from 18 defined spits were available. Material from two spits (N=4) were removed from analysis due to lack of contextual information, leaving material from 16 spits (Table 97). The lithic material is very unevenly distributed within each spit and amongst the cuts (Figure 63). A concentration of material is present towards the lower part of the deposit (Figure 64). This concentration is further clustered in cuts situated in the western part of the excavated area. Figure 65 show the contrast in lithic distribution between the upper and lower half of the deposit.

The lithic assemblage, as mentioned above, is core and flake based, i.e. no hand axes are present. In Unit S10, almost 50% of the flakes analysed are modified, with ca. 20% tools, and almost 30% retouched flakes, including core-on-flakes (Table 98).

The retouched and un-retouched tools are divided into nine different categories, some of which are considered multi-tools (Table 99). They are dominated by various typological forms of scrapers, Mousterian points, and Levallois points, together with burins (i.e. pieces with modification identified as burination).

Cuts C-8, D-7, and D-8 by far have the largest concentration of lithics compared to the other cuts (Table 100) and cut D-7 has the broadest variety of tools (Table 101).

The Levallois component of Unit S10 is identified at 14.5% (Table 102).

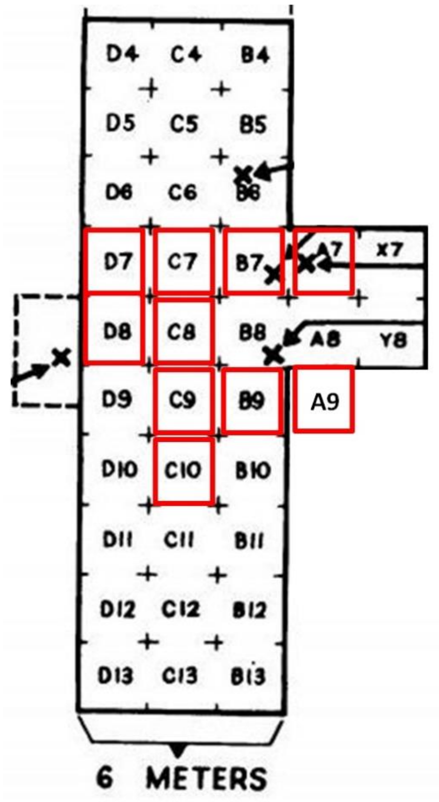

Figure 62 - Shanidar excavation grid with 2 x 2 m squares (cuts): Unit S10 is marked in red (adapted from Solecki 1971).

Cut	Frequency	Percent
A-7	3	1.8
A-9	1	.6
B-7	7	4.2
B-9	2	1.2
C-7	1	.6
C-8	33	20.0
C-9	9	5.5
C-10	1	.6
D-7	79	47.9
D-8	29	17.6
Total	**165**	**100.0**

Table 96 - Unit S10: Shanidar Layer D flakes by cut (whole and broken flakes) (N=165)

Spit	Frequency	Percent
4.00-4.25	1	.6
4.25-4.50	2	1.2
4.45	1	.6
5.40	2	1.2
5.50-5.75	1	.6
5.75-6.00	3	1.8
6.25-6.50	1	.6
6.75-7.00	14	8.5
7.00-7.25	21	12.7
7.20-7.75	21	12.7
7.25-7.50	1	.6
7.50-7.75	20	12.1
7.75-8.00	15	9.1
8.00-8.25	7	4.2
8.25-8.50	36	21.8
8.75-9.00	19	11.5
Total	**165**	**100.0**

Table 97 - Unit S10 – Shanidar Layer D flakes by spit (whole and broken flakes) (N=165)

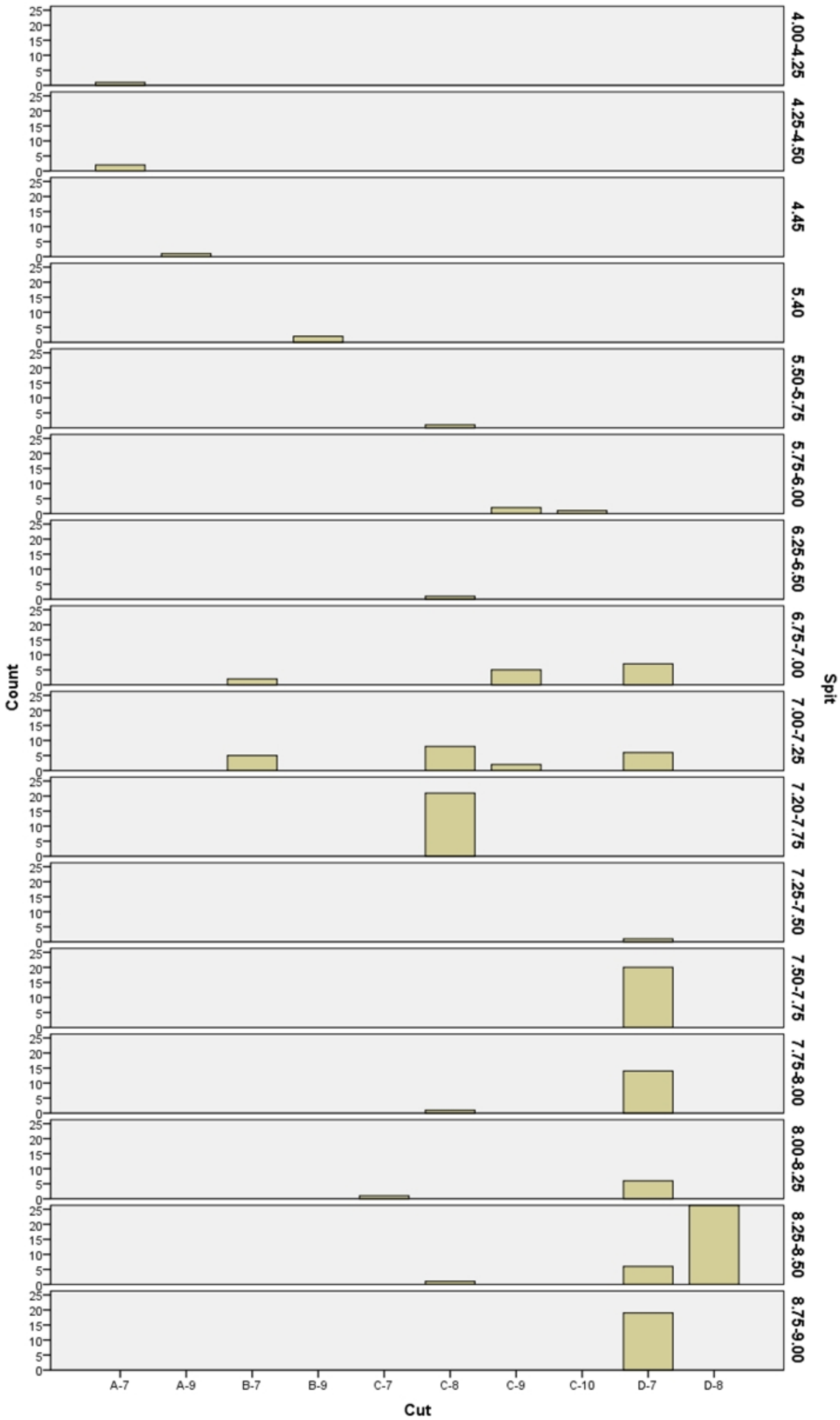

Figure 63 - Unit S10 – Distribution of Shanidar Layer D lithics within each spit and amongst the cuts. Right hand side Y-axis designate spits

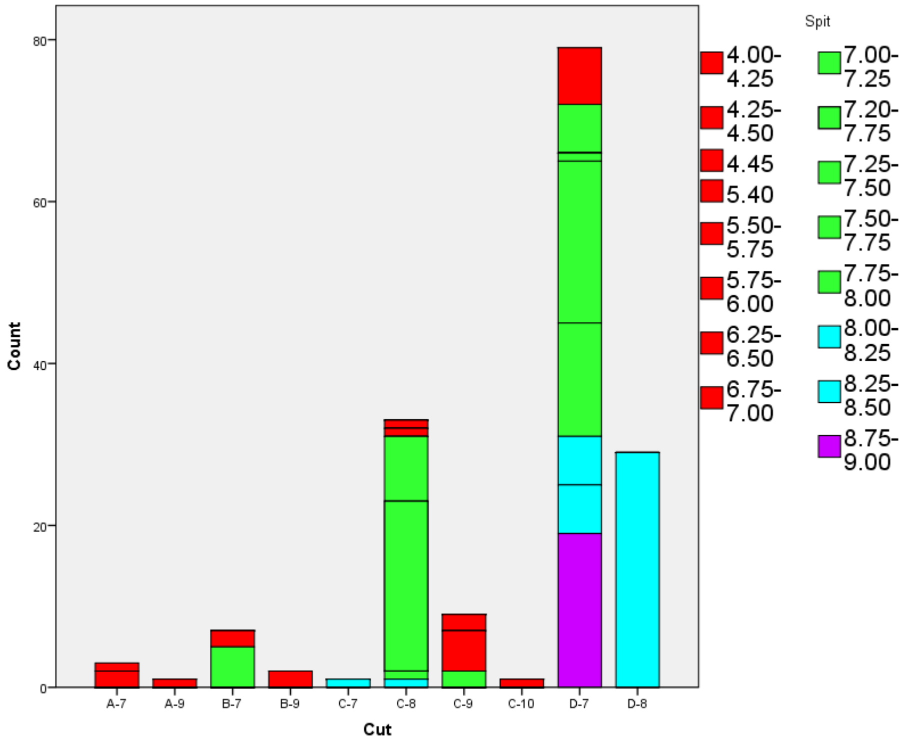

Figure 64 - Unit S10 – Concentration of Shanidar Layer D material present towards the lower part of the deposit

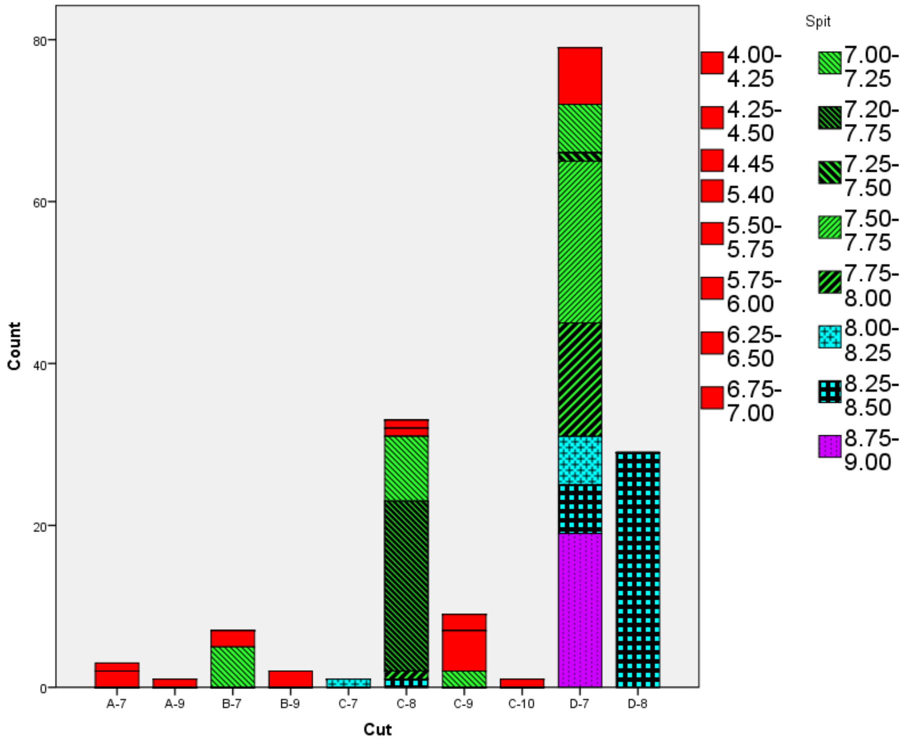

Figure 65 - Unit S10 – Contrast in Shanidar Layer D lithic distribution between the upper and lower half of the deposit.

Data class	Frequency	Percent
CoreOnFlake	7	4.2
RetouchedFlake	39	23.6
UnretouchedFlake	87	52.7
Tool	30	18.2
Multi-Tool	2	1.2
Total	**165**	**100.0**

Table 98 - Unit S10: Shanidar Layer D flakes by data class (whole and broken flakes) (N=165)

Tool type	Frequency
Single Scraper	2
Double Scraper	2
Convergent Scraper	3
Burin	14
Mousterian Point	3
Single Scraper and Burin	1
Burin and Notch	1
Borer/Bec/Priser	3
Levallois Point	3
Total	**32**

Table 99 - Unit S10 – Shanidar Layer D flakes by tool type (whole and broken flakes) (N=165)

		Cut									
		A-7	A-9	B-7	B-9	C-7	C-8	C-9	C-10	D-7	D-8
		Count	Count	Count	Count	Count	Count	Count	Count	Count	Count
DataClass	CoreOnFlake	**1**	0	**2**	0	0	0	0	0	**4**	0
	RetouchedFlake	0	0	**3**	0	0	**9**	**2**	**1**	**18**	**6**
	UnretouchedFlake	**2**	**1**	0	**1**	0	**17**	**2**	0	**43**	**21**
	Tool	0	0	**2**	**1**	**1**	**7**	**5**	0	**12**	**2**
	Multi-Tool	0	0	0	0	0	0	0	0	**2**	0
	Total	**3**	**1**	**7**	**2**	**1**	**33**	**9**	**1**	**79**	**29**

Table 100 - Unit S10 – Shanidar Layer D flakes – Data class by cut (whole and broken flakes) (N=165)

		Cut									
		A-7	A-9	B-7	B-9	C-7	C-8	C-9	C-10	D-7	D-8
		Count	Count	Count	Count	Count	Count	Count	Count	Count	Count
ToolType	Single Scraper	0	0	0	0	0	0	**1**	0	**1**	0
	Double Scraper	0	0	0	0	**1**	0	**1**	0	0	0
	Convergent Scraper	0	0	0	0	0	0	1	0	**2**	0
	Transverse Scraper	0	0	0	0	0	0	0	0	0	0
	End Scraper	0	0	0	0	0	0	0	0	0	0
	Burin	0	0	0	0	0	**5**	**2**	0	**5**	**2**
	Mousterian Point	0	0	0	0	0	**1**	0	0	**2**	0
	Single Scraper and Burin	0	0	0	0	0	0	0	0	**1**	0
	Burin and Notch	0	0	0	0	0	0	0	0	**1**	0
	Notch	0	0	0	0	0	0	0	0	0	0
	Borer/Bec/Priser	0	0	**1**	0	0	0	0	0	**2**	0
	Denticulate	0	0	0	0	0	0	0	0	0	0
	Levallois Point	0	0	**1**	**1**	0	**1**	0	0	0	0
	Burin and Point	0	0	0	0	0	0	0	0	0	0
	Levallois Point and Notch	0	0	0	0	0	0	0	0	0	0
	Total	**0**	**0**	**2**	**1**	**1**	**7**	**5**	**0**	**14**	**2**

Table 101 - Unit S10 - Shanidar Layer D flakes - tool type by cut (whole and broken flakes) (N=165)

	Frequency	Percent
Yes	24	14.5
No	141	85.5
Total	165	100.0

Table 102 - Unit S10 – Shanidar Layer D – Levallois flakes (whole and broken flakes) (N=165)

Unit S6

All six cuts (B-7, C-7, C-8, C-9, D-7, and D-8) with material from either layers D4a, D4b, or D4c could be included in analysis in order to boost as much as possible the number of lithics from the horizons of interest. We will call this unit of analysis “**Unit S6**”. However, what is gained in numbers is either lost in horizontal and vertical admixture, or in the cumulative possibility of uncertainty with regards to human error in sampling, the likelihood of which is possible at any excavation, an issue which is directly proportional to the aggregate of sample units. The total volume of this deposit is $48m^3$ ($24m^2$ horizontally by two meters vertically). The total number of flakes from Unit S6 is 140.

Unit S5

Five cuts (B-7, C-8, C-9, D-7, and D-8) are clearly richer in lithics than the other half of the included cuts (A-7, A-9, B-9, C-7, and C-10). Material from layers D4a, D4b, or D4c could be singled out to reduce the horizontal range, and possibly allow for stronger behavioural signals within a reduced space. We will call this unit of analysis “**Unit S5**” (tables 103-104). The total number of flakes from Unit S5 is 139. The total volume of this deposit is $40m^3$ ($20m^2$ horizontally by two meters vertically).

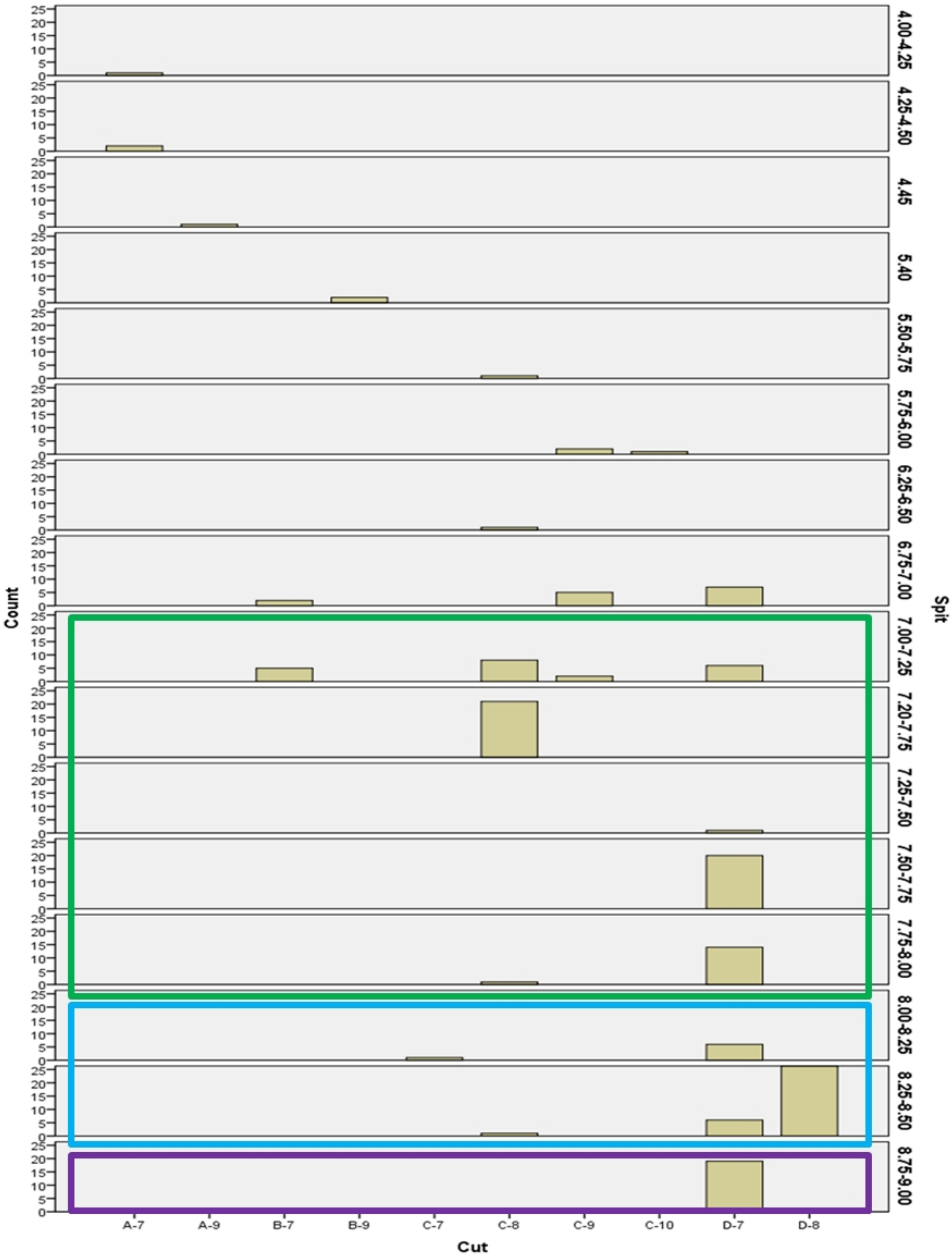

Figure 66 - Unit S10 – Shanidar Layer D4a (green), D4b (blue), and D4c (purple) flakes – Cut by Spit by Count (whole and broken flakes) (N=165) Right hand side Y-axis designate spits.

Unit S2

Two cuts, D-7 and D-8, are more abundant in lithics than the rest, one of which has concentrations of lithics from all three relevant sub-layers of Layer 4D. We will call this unit of analysis "**Unit S2**". The total volume of this deposit is 16m³ (8m² horizontally by two meters vertically). The total number of flakes from Unit S2 is 101.

				DataClass1				
				CoreOnFlake	RetouchedFlake	UnretouchedFlake	Tool	Multi-Tool
				Count	Count	Count	Count	Count
Cut1	B-7	Spit1	7.00-7.25	0	1	0	0	0
			7.20-7.75	0	0	0	0	0
			7.25-7.50	0	0	0	0	0
			7.50-7.75	0	0	0	0	0
			7.75-8.00	0	0	0	0	0
			8.00-8.25	0	0	0	0	0
			8.25-8.50	0	0	0	0	0
			8.75-9.00	0	0	0	0	0
			Total	0	1	0	0	0
	C-8	Spit1	7.00-7.25	0	1	0	2	0
			7.20-7.75	0	0	6	0	0
			7.25-7.50	0	0	0	0	0
			7.50-7.75	0	0	0	0	0
			7.75-8.00	0	0	0	0	0
			8.00-8.25	0	0	0	0	0
			8.25-8.50	0	0	0	0	0
			8.75-9.00	0	0	0	0	0
			Total	0	1	6	2	0
	C-9	Spit1	7.00-7.25	0	0	0	0	0
			7.20-7.75	0	0	0	0	0
			7.25-7.50	0	0	0	0	0
			7.50-7.75	0	0	0	0	0
			7.75-8.00	0	0	0	0	0
			8.00-8.25	0	0	0	0	0
			8.25-8.50	0	0	0	0	0
			8.75-9.00	0	0	0	0	0

		Total	0	0	0	0	0
D-7	Spit1	7.00-7.25	0	0	1	0	1
		7.20-7.75	0	0	0	0	0
		7.25-7.50	0	0	0	1	0
		7.50-7.75	0	1	5	1	0
		7.75-8.00	0	0	4	3	0
		8.00-8.25	0	1	1	1	0
		8.25-8.50	0	1	3	0	0
		8.75-9.00	0	1	8	0	0
		Total	0	4	22	6	1
D-8	Spit1	7.00-7.25	0	0	0	0	0
		7.20-7.75	0	0	0	0	0
		7.25-7.50	0	0	0	0	0
		7.50-7.75	0	0	0	0	0
		7.75-8.00	0	0	0	0	0
		8.00-8.25	0	0	0	0	0
		8.25-8.50	0	2	10	0	0
		8.75-9.00	0	0	0	0	0
		Total	0	2	10	0	0

Table 103 - Unit S5 – Shanidar Layer D4a, D4b, and D4c flakes – Cut and Spit by DataClass

Data class	Frequency	Percent
RetouchedFlake	8	14.5
UnretouchedFlake	38	69.1
Tool	8	14.5
Multi-Tool	1	1.8
Total	**55**	**100.0**

Table 104 - Unit S5 – Shanidar Layer D4a, D4b, and D4c – flakes by Data Class (whole flakes) (N=55)

6.6.3 Shanidar Layer D4a

Layer D4a is represented in cuts B-7, C-8, C-9, and D-7, although cut C-9 only supply two broken tools. The three remaining cuts encompass an area of 12m² and Layer D4a, as a distinct cultural deposit, comprises about 110 cm of sediment within the vertical stratigraphy. 27 whole flakes are available from this layer (Table 105). 16 unretouched flakes, 3 retouched flakes, and 8 tools. What immediately stands out is the almost even distribution between unmodified and modified flakes (including unretouched tools). If broken flakes are considered, the assemblage is increased three times. With the inclusion of broken pieces, more than half of the flake assemblage is modified (Table 106). This would seem to be significant, with the substantiated assumption that the excavator curated all flints from the sounding. The tools found in this layer are scrapers and burins (Table 107). If broken flakes are included, the numbers for both tool categories are doubled, but the tool inventory itself not significantly diversified (Table 108).

The recognition that the available lithic assemblage for this study only is part of the original curated collection housed in the US, itself only a fraction of the material housed in Baghdad, notwithstanding, it seems appropriate to limit the spatio-temporal distribution of lithics analysed here by narrowing down the surface area between cuts, so as to concentrate as high a proportion of lithics as possible within as small a space as possible. Doing this, arguably, will increase the resolution of the behavioural signature afforded by the stone tools. Reducing the area horizontally by focusing on only the two lithic-rich cuts of D-7 and D-8, the behavioural zone is reduced by 60%, from $20m^2$ to $8m^2$ (Figure 67). The resulting distribution of lithics in layer D4a, based on a reduction in cuts, furnishes essentially the same pattern as does the full area (tables 109-112).

Data class	Frequency	Percent
RetouchedFlake	3	11.1
UnretouchedFlake	16	59.3
Tool	7	25.9
Multi-Tool	1	3.7
Total	27	100.0

Table 105 - Unit S5(S3) – Shanidar Layer D4a, cuts B-7, C-8, and D-7 (12m²) – whole flakes by data class

Data class	Frequency	Percent
CoreOnFlake	3	3.8
RetouchedFlake	21	26.9
UnretouchedFlake	35	44.9
Tool	17	21.8
Multi-Tool	2	2.6
Total	78	100.0

Table 106 - Unit S5(S4) **–** *Shanidar Layer D4a cuts B-7, C-8, C-9, and D-7* ***(16m²)*** *– whole and broken flakes by data class.*

Tool type	Frequency
Single Scraper and Burin	1
Convergent Scraper	1
Mousterian Point	2
Burin	4
Total	**8**

Table 107 - Unit S5 – Shanidar Layer D4a – whole flakes by tool type.

Tool type	Frequency
Single Scraper	1
Single Scraper and Burin	1
Convergent Scraper	3
Mousterian Point	3
Burin	8
Burin and Notch	1
Borer/Bec/Priser	2
Total	**19**

Table 108 - Unit S5 – Shanidar Layer D4a – whole and broken flakes by tool type.

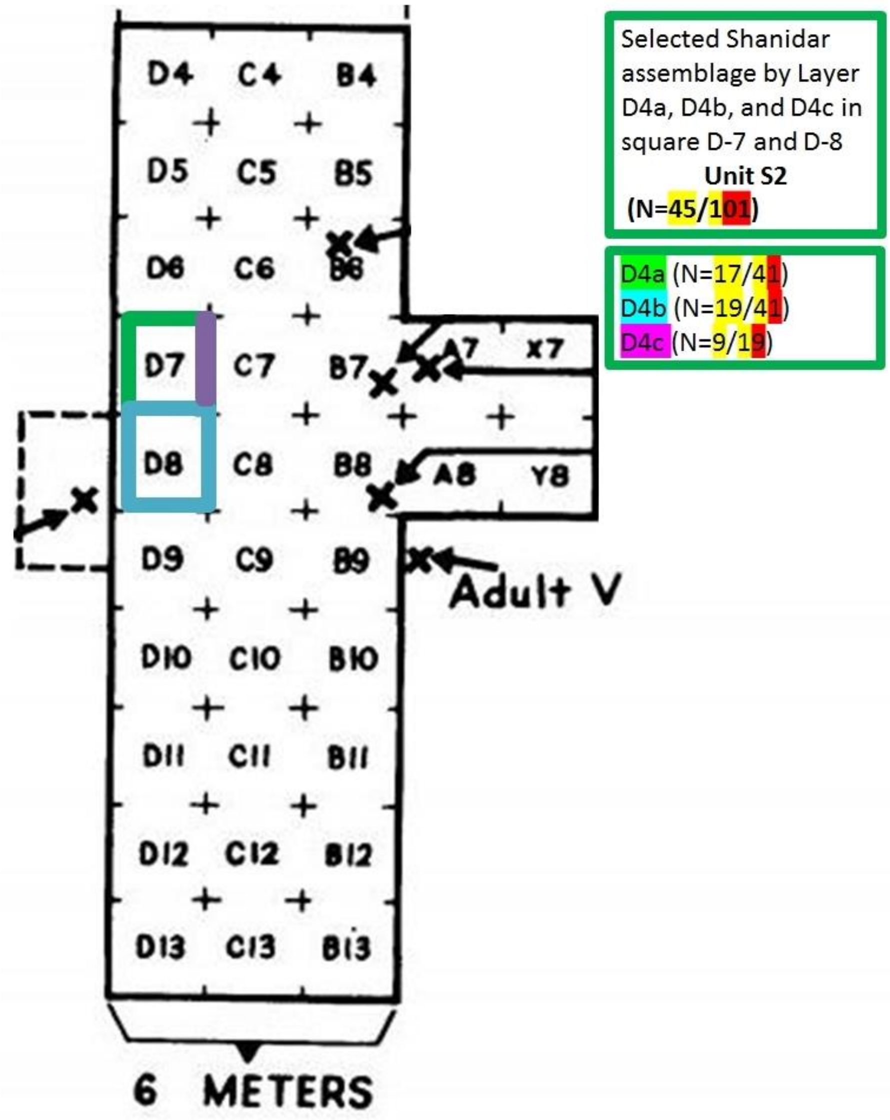

Figure 67 - Unit S2 – Shanidar Layer D4a, D4b, and D4c – The two lithic-rich cuts, D-7 and D-8, showing figures for whole and broken pieces. Yellow = whole. Yellow and red = whole and broken flakes combined (adapted from Solecki 1971).

Data class	Frequency	Percent
RetouchedFlake	1	5.9
UnretouchedFlake	10	58.8
Tool	5	29.4
Multi-Tool	1	5.9
Total	**17**	**100.0**

Table 109 - Unit S2(S1) – Shanidar Layer D4a, cut D-7 – whole flakes by data class

Type	Frequency	Percent
CoreOnFlake	2	4.9
RetouchedFlake	10	24.4
UnretouchedFlake	19	46.3
Tool	8	19.5
Multi-Tool	2	4.9
Total	**41**	**100.0**

Table 110 - Unit S2(S1) – Shanidar Layer D4a, cut D-7 – whole and broken flakes by data class

Tool type	Frequency
Convergent Scraper	1
Burin	2
Mousterian Point	2
Single Scraper and Burin	1
Tool	**6**
Total	**17**

Table 111 - Unit S2 – Shanidar Layer D4a – whole flakes by tool type

Tool form	Frequency
Single Scraper	1
Convergent Scraper	2
Burin	2
Mousterian Point	2
Single Scraper and Burin	1
Burin and Notch	1
Borer/Bec/Priser	1
Total	**10**

Table 112 - Unit S2 – Shanidar Layer D4a – whole and broken flakes by tool type

6.6.4 Shanidar Layer D4b

Layer D4b is a 60 cm deep horizon identified between 8.10 and 8.70 meters below datum. It is mostly attested in cut D-8 (N=29) with small amounts in cuts D-7 (N=6) and C-8 (N=1) (Figure 67). A spit immediately above is situated mostly in Layer D4b (8:00-8:25 m) but could be claimed to be mixed. For this reason, this spit will be excluded from analysis. This spit is represented in cuts D-7 (N=6) and C-7 (N=1).

Only 19 whole flakes were available for study from Layer D4b. 4 retouched flakes and 14 unretouched, with 1 tool, a burin (Table 113). Including the broken flakes, the number of pieces double, with the distribution staying the same. The number of retouched flakes double to 9, the unretouched flakes to 30, and the number of burins increase to 3 (Table 114-115).

Data class	Frequency	Percent
RetouchedFlake	4	21.1
UnretouchedFlake	14	73.7
Tool	1	5.3
Total	19	100.0

Table 113 - Unit S2 – Shanidar Layer D4b – whole flakes by data class

Data class	Frequency	Percent
RetouchedFlake	9	21.4
UnretouchedFlake	30	71.4
Tool	3	7.1
Total	42	100.0

Table 114 - Unit S2 – Shanidar Layer D4b – whole and broken flakes by data class

				DataClass					
				CoreOnFlake	RetouchedFlake	UnretouchedFlake	Tool	Multi-Tool	Total
				Count	Count	Count	Count	Count	Count
Cut	D-7	Spit	8.00-8.25	0	1	1	1	0	3
			8.25-8.50	0	1	3	0	0	4
			Total	**0**	**2**	**4**	**1**	**0**	**7**
	D-8	Spit	8.25-8.50	0	2	10	0	0	12
			Total	**0**	**2**	**10**	**0**	**0**	**12**

Table 115 - Unit S2 – Shanidar Layer D4b – whole flakes by cut/spit by data class

6.6.5 Shanidar Layer D4c

Layer D4c is attested only in cut D-7 and just 9 whole flakes are available for analysis. This sub-layer of Layer D4 is, stratigraphically, larger than the former, D4b, with a depth of 130 cm, making it similar in size to layer D4a. 1 retouched flake and 8 unretouched flakes make up the whole flake population (Table 116). Similar to Layer D4b, by including the broken part of the assemblage, the count for retouched and unretouched flakes double. Also part of the broken assemblage is a core-on-flake and a burin (Table 117-118).

Data class	Frequency	Percent
RetouchedFlake	1	11.1
UnretouchedFlake	8	88.9
Total	**9**	**100.0**

Table 116 - Unit S2 – Shanidar Layer D4c – whole flakes by data class

Data class	Frequency	Percent
CoreOnFlake	1	5.3
RetouchedFlake	2	10.5
UnretouchedFlake	15	78.9
Tool	1	5.3
Total	**19**	**100.0**

Table 117 - Unit S2 – Shanidar Layer D4c – whole and broken flakes by data class

	DataClass					
	CoreOnFlake	RetouchedFlake	UnretouchedFlake	Tool	Multi-Tool	Total
	Count	Count	Count	Count	Count	Count
Cut D-7 Spit 8.75-9.00	0	1	8	0	0	9
Total	**0**	**1**	**8**	**0**	**0**	**9**

Table 118 - Unit S2 – Shanidar Layer D4c – whole flakes by cut/spit by data class

6.6.6 Shanidar Layer D4a, D4b, and D4c

6.6.6.1 Analysis of flakes from cuts D-7 and D-8: Unit S2

With the above stratigraphically geared taphonomic assessment of the spatio-temporal integrity of the available Shanidar Layer D lithic assemblage, it seems reasonable to focus the interpretive attention on the potential afforded by the material of layers D4a, D4b, and D4c, concentrated in cuts D-7 and D-8.

Below will be presented a techno-typological description of the Shanidar Layer D assemblage available from sub-layers D4a, D4b, and D4c from cuts D-7 and D-8: Unit S2. While the amount of the available material, unfortunately, in many cases is too small for statistically meaningful conclusions, I will aim to demonstrate that much valuable information can still be obtained. When deemed beneficial to the overall goal of the study, namely gaining insights into the Middle Palaeolithic lithic technological behaviour at Shanidar as compared to the other sites examined in this thesis, analysis of Unit S2 material will be augmented by comparative material from Unit S5.

6.6.6.2 Flake assemblage by techno-typology

Flake dimensions

Starting with examining mean proportions of the flakes, a slight increase in mean **flake length** from layer D4c through D4b to D4a is visible (Table 119-121). This chronological increase is echoed in **Flake Length P**. **Maximum width** is fairly stable through the 3 sublayers, with the small sample from D4c being slightly wider. With **max thickness**, it is the younger sublayer, D4a, which flakes is showing slightly thicker than the two other samples, who in this category are about equal. All in all, it must be concluded, that the small discrepancies notwithstanding, the three analysed assemblages are relatively similar in dimensions.

	N	Minimum	Maximum	Mean
Max length	16	11.77	59.69	35.3887
Flake length P	16	11.70	54.59	33.2938
Max width	16	6.04	33.59	19.6512
Max thickness	16	1.49	18.60	7.5313

Table 119 - Unit S2 - Shanidar Layer D4a – Length, Width, Thickness

	N	Minimum	Maximum	Mean
MaxLength	19	14.24	38.75	26.8837
FlakeLengthP	19	14.33	38.95	24.8205
MaxWidth	19	10.24	38.01	19.5332
MaxThickness	19	2.18	10.84	5.5805

Table 120 - Unit S2 – Shanidar Layer D4b – Length, Width, Thickness

	N	Minimum	Maximum	Mean
MaxLength	9	15.27	39.31	23.8067
FlakeLengthP	9	14.79	39.35	23.1967
MaxWidth	9	14.14	28.80	22.0133
MaxThickness	9	3.27	9.99	5.8533

Table 121 - Unit S2 – Shanidar Layer D4c – Length, Width, Thickness

6.6.7 Dorsal indices of flakes

6.6.7.1 Dorsal scar count

Dorsal scar count within layer D4a flakes are pretty evenly distributed with three and four scars showing a slight predominance, with a mean of 3.4 dorsal scars per flake (Table 122). D4b flakes have marginally more scars with a mean of 4.6 per flake (Table 123). D4c flakes display an average of 3.6 flake scars per flake (Table 124). At face value, these are quite similar distributions.

Dorsal scar count	Frequency
0	2
1	2
2	1
3	3
4	3
5	1
9	2
Total	**14**

Table 122 - Unit S2 – Shanidar Layer D4a – dorsal scar count

Dorsal scar count	Frequency
1	1
2	1
3	2
4	4
5	2
6	5
7	2
Total	**17**

Table 123 - Unit S2 – Shanidar Layer D4b – dorsal scar count

Dorsal scar count	Frequency
0	1
3	2
4	2
5	3
Total	**8**

Table 124 - Unit S2 – Shanidar Layer D4c – dorsal scar count

6.6.7.2 Dorsal scar pattern

The reasons for recording dorsal scar pattern is the insight the data can provide on core reduction strategies, specifically amount of core rotation, stage(s) of reduction, and extent of raw material exploitation. As it is generally impossible to determine whether a flake with a unidirectional scar pattern has been produced through a scheme involving core rotation, unidirectional detachments can only be viewed as associated with non-rotating core reduction, which is assumed to bespeak initial stages of core exploitation. Bidirectional and lateral (right, left) detachments involve at least one act of core rotation, which in comparison to unidirectionally-patterned pieces is assumed to place these pieces in a later phase of core exploitation. Multidirectional and any type of radial detachments have been involved in at least two acts of core rotation, which again is assumed to be a proxy for later stages of core exploitation compared to the above-mentioned types.

Looking at the three layers (table 125-127), the low number of identified dorsal scar patterns makes it almost impossible to glean any meaningful signals. What can be tentatively highlighted is what could be said to be an even share of earlier and later stage reduction in Layer D4a. The population in Layer D4b shows a slight difference with a prominence of scars suggesting later stage reduction. The data in Layer D4c is insufficient to make any statement beyond noting the presence of both early and later stage flakes.

The reason for the relatively high number of pieces in the "indeterminate" category, is due to the strict adherence to the methodology, specifically with respect to the radically rigorous classification system for identifying dorsal scar patterns, purposely developed for this thesis (see Chapter 4). If just one scar in the dorsal pattern was unidentifiable in a way not covered by the otherwise multiple set of types, it would be put in the "indeterminate" category. With hindsight (based on conducting my data analyses) this is a flaw in the system which favours "uncomplicated" dorsal scar patterns such as unidirectional, bidirectional, and lateral, while at the same time masking "complicated", i.e. radial scar patterns such as multidirectional, weakly-, and strongly radial. This should be corrected for in future studies by reconfiguring the dorsal scar pattern classification system.

Dorsal scar pattern	Frequency	Percent
Proximal	2	11.8
Right	1	5.9
BidirectionalProximalDistal	1	5.9
IndeterminateUni-BidirProximalDistal	3	17.6
Indeterminate(but radial)	1	5.9
WhollyCortical	2	11.8
Obscured	3	17.6
Indeterminate	4	23.5
Total	**17**	**100.0**

Table 125 - Unit S2 – Shanidar Layer D4a – Dorsal scar pattern

Dorsal scar pattern	Frequency	Percent
Proximal	1	5.3
IndeterminateUni-BidirProximalDistal	2	10.5
Multi-directional	1	5.3
WeaklyRadial	2	10.5
StronglyRadial	1	5.3
Indeterminate(but radial)	1	5.3
Obscured	3	15.8
Indeterminate	8	42.1
Total	**19**	**100.0**

Table 126 - Unit S2 – Shanidar Layer D4b – Dorsal scar pattern

Dorsal scar pattern	Frequency	Percent
Multi-directional	1	11.1
WeaklyRadial	1	11.1
WhollyCortical	1	11.1
Obscured	1	11.1
Indeterminate	5	55.6
Total	**9**	**100.0**

Table 127 - Unit S2 – Shanidar Layer D4c – Dorsal scar pattern

6.6.7.3 Dorsal cortex and cortex location

In layer D4a, 60% of the flakes are completely decorticated (Table 128). The remaining part of the flakes are distributed pretty evenly throughout the table. Collapsing this more fine-grained, seven-tiered grouping of cortex retention into a three-tiered ranking (Table 131), the low amount of cortex retention is even more pronounced at 70%. The flakes of layer D4b are overwhelmingly decorticated (tables 129-132). This distribution is even sharper than in layer D4a. This picture is replicated in layer D4c (tables 130 and 133).

These findings can be interpreted as complimenting the insights gained from the analysis of dorsal scar pattern above, by suggesting later stage core reduction. Specifically, flakes with uncomplicated dorsal scar patterns could, in light of the insights from cortex retention, and contrary to conventional arrangement, be interpreted as deriving from reduction of already previously decorticated (primary), and secondarily knapped, volumetrically reduced cores. As such, their uncomplicated dorsal scar pattern would not indicate early (primary/secondary) but rather later stage (secondary/tertiary) core reduction.

From tables 128-130 it is apparent that cortex retention for the flakes from all three layers is restricted to the dorsal surface, with no evidence for cortex retention on butts. Even when broken flakes are consulted, this situation does not change. This is another argument that initial stage core reduction, i.e. the first stage of decortication of a "fresh" nodule, was not practiced within the layers covered in this study. The behavioural implication of this would be that nodule cores/core blanks being brought into the cave would already have had a sufficient amount of cortex removed for an assumed random sample (curated by the excavator) to include no initial stage decortication flakes, displaying cortical butts. Considering that cores would have had to be brought in from quite some distance, i.e. as a minimum from the Greater Zab River down in the valley, it would seem reasonable to assume that cores were carefully tested before being transported all the way up to the cave. An alternative, though admittedly rather behaviourally unlikely, explanation would be that cortical flakes were being removed from the area of general discard, either by being targeted for further transport or discarded in another area.

Dorsal cortex	Frequency	Percent
0%	10	58.8
1-25%	1	5.9
26-50%	1	5.9
ca50%	1	5.9
51-75%	2	11.8
100%	2	11.8
Total	**17**	**100.0**

Table 128 - Unit S2 – Shanidar Layer D4a – Dorsal cortex

Dorsal cortex	Frequency	Percent
0%	17	89.5
26-50%	1	5.3
ca50%	1	5.3
Total	**19**	**100.0**

Table 129 - Unit S2 – Shanidar Layer D4b – Dorsal cortex

Dorsal cortex	Frequency	Percent
0%	8	88.9
100%	1	11.1
Total	**9**	**100.0**

Table 130 - Unit S2 – Shanidar Layer D4c – Dorsal cortex

Dorsal cortex	Frequency	Percent
0-25%	12	70.6
25-75%	3	17.6
75-100%	2	11.8
Total	17	100.0

Table 131 - Unit S2 – Shanidar Layer D4a – Dorsal cortex 3 groups

Dorsal cortex	Frequency	Percent
0-25%	17	89.5
25-75%	2	10.5
Total	**19**	**100.0**

Table 132 - Unit S2 – Shanidar Layer D4b – Dorsal cortex 3 groups

Dorsal cortex	Frequency	Percent
0-25%	8	88.9
75-100%	1	11.1
Total	**9**	**100.0**

Table 133 - Unit S2 – Shanidar Layer D4c – Dorsal cortex 3 groups

Dorsal cortex	Frequency	Percent
DorsalOnly	7	41.2
None	10	58.8
Total	**17**	**100.0**

Table 134 - Unit S2 – Shanidar Layer D4a – Dorsal cortex location

Dorsal cortex	Frequency	Percent
DorsalOnly	2	10.5
None	17	89.5
Total	**19**	**100.0**

Table 135 - Unit S2 – Shanidar Layer D4b – Dorsal cortex location

Dorsal cortex	Frequency	Percent
DorsalOnly	1	11.1
None	8	88.9
Total	**9**	**100.0**

Table 136 - Unit S2 – Shanidar Layer D4c – Dorsal cortex location

6.6.7.4 Redirection flakes

That redirecting flakes (tables 137-139) are so prominently absent across the assemblage is somewhat surprising, given the assumption that this particular technological articulation is a tell-tale sign of core rotation. Core rotation, as noted above, is assumed to be evidenced by other technological traits visible on the flakes in the assemblage. Even when consulting the broken-flake assemblage (tables 140-142), the numbers stay low. A possible explanation could be that redirecting flakes are more common in association with larger cores. The three cores available for this study were relatively small. Thus, an interpretive argument is that the core reduction within the layers under discussion involved cores of a sufficiently diminutive size so as to preclude extensive core rotation, thereby keeping numbers of redirection flakes to a minimum.

Redirection flakes	Frequency	Percent
Yes	1	5.9
No	16	94.1
Total	**17**	**100.0**

Table 137 - Unit S2 – Shanidar Layer D4a – Redirection flakes

Redirection flakes	Frequency	Percent
Yes	1	5.3
No	18	94.7
Total	**19**	**100.0**

Table 138 - Unit S2 – Shanidar Layer D4b – Redirection flakes

Redirection flakes	Frequency	Percent
No	9	100.0

Table 139 - Unit S2 – Shanidar Layer D4c – Redirection flakes

Redirection flakes	Frequency	Percent
Yes	2	4.9
No	39	95.1
Total	**41**	**100.0**

Table 140 - Unit S2 – Shanidar Layer D4a – Redirection flakes: whole and broken flakes

Redirection flakes	Frequency	Percent
Yes	1	2.4
No	40	97.6
Total	**41**	**100.0**

Table 141 - Unit S2 – Shanidar Layer D4b – Redirection flakes: whole and broken flakes

Redirection flakes	Frequency	Percent
Yes	1	5.3
No	18	94.7
Total	**19**	**100.0**

Table 142 - Unit S2 – Shanidar Layer D4c – Redirection flakes: whole and broken flakes

6.6.8 Proximal indices of flakes

6.6.8.1 Butt type/platform

A variety of butt types are visible in each of the three assemblages (tables 143-145). Plain butts occur in each layer, but whereas they constitute around 50% in the two older layers, this category only comprise about 12% in layer D4a.

As only three butt types: *cortical*, *natural* (but non-cortical), and *mixed* (e.g. combination of natural and flaked surfaces), in my classificatory scheme of 12 distinct butt types, explicitly suggest primary or initial stage flaking, using plain butts as a proxy for early stage flaking is not entirely satisfactory. A more specifically techno-typological approach would be to evaluate plain butts against dihedral, facetted, and marginal butts, also occurring in the assemblages. Marginal butts can be said to have been adopted out of necessity in reduction, i.e. due to limited platform real estate, rather than an operative choice (in contrast to dihedral and facetted options) which arguably would situate them closer to the plain butts, which is seen as the most common variant amongst the assemblages. As discussed in the previous chapter, facetted and dihedral butt types can be associated with prepared core technology such as Levallois, and in the case of dihedral butts, discoidal reduction as well. Erring on the side of caution, however, it must be assumed that those two latter butt types cannot exclusively be attributed to specific reduction schemes. This would seem to point to a relatively evenly distributed sample of earlier and later stage proxies for flaking in Layer D4a. In Layer D4b and D4c, the data seems to suggest a leaning towards later stage reduction. However, with the small samples available, this should be taken as a tentative corroboration of the above interpretations drawn from dorsal scar patterns and cortex retention.

Butt type	Frequency	Percent
Plain	2	11.8
Dihedral	1	5.9
Marginal	4	23.5
Facetted	4	23.5
Obscured(e.g.bydamage)	3	17.6
Retouched	3	17.6
Total	**17**	**100.0**

Table 143 - Unit S2 – Shanidar Layer D4a – Butt type

Butt type	Frequency	Percent
Plain	9	47.4
Dihedral	1	5.3
Marginal	2	10.5
Facetted	5	26.3
Trimmed	1	5.3
Obscured(e.g.bydamage)	1	5.3
Total	**19**	**100.0**

Table 144 - Unit S2 – Shanidar Layer D4b – Butt type

Butt type	Frequency	Percent
Plain	5	55.6
Marginal	1	11.1
Facetted	2	22.2
Obscured(e.g.bydamage)	1	11.1
Total	**9**	**100.0**

Table 145 - Unit S2 – Shanidar Layer D4c – Butt type

6.6.9 Distal indices of flakes

6.6.9.1 Flake termination

Flake terminations are overwhelmingly feathered (tables 146-148). The most obvious explanation for this is likely that two out of six variants (step and axial) would be associated with broken flakes and therefore not included with the whole-flake assemblage (tables 149-151).

It is impossible to know anything about the proficiency of the knappers responsible for the assemblage. However, it must be assumed that they were likely very capable and therefore as a consequence produced flake blanks and debitage to the best of their ability. This would then mean that, based on their low numbers, what is referred to as *hinge* and *overshot* terminations, while technologically whole flakes, were either not coveted by the hominins, or, if they ever existed in greater numbers, have been either transformed (i.e. through retouch), discarded elsewhere, or transported away from the cave. The most likely scenario is that they were rarely consciously produced, as flakes with feather terminations were preferred for blanks.

	Frequency	Percent
Feather	12	70.6
Hinge	1	5.9
Plunging/Overshot	1	5.9
Retouched	3	17.6
Total	**17**	**100.0**

Table 146 - Unit S2 – Shanidar Layer D4a – Flake termination

Flake termination	Frequency	Percent
Feather	18	94.7
Retouched	1	5.3
Total	**19**	**100.0**

Table 147 - Unit S2 – Shanidar Layer D4b – Flake termination

Flake termination	Frequency	Percent
Feather	6	66.7
Hinge	2	22.2
Retouched	1	11.1
Total	**9**	**100.0**

Table 148 - Unit S2 – Shanidar Layer D4c – Flake termination

Flake termination	Frequency	Percent
Feather	15	36.6
Hinge	1	2.4
Step(break/snap)	15	36.6
Plunging/Overshot	1	2.4
Retouched	9	22.0
Total	**41**	**100.0**

Table 149 - Unit S2 – Shanidar Layer D4a – Flake termination: whole and broken flakes

	Frequency	Percent
Feather	25	61.0
Step(break/snap)	14	34.1
Plunging/Overshot	1	2.4
Retouched	1	2.4
Total	**41**	**100.0**

Table 150 - Unit S2 – Shanidar Layer D4b – Flake termination: whole and broken flakes

Flake termination	Frequency	Percent
Feather	7	36.8
Hinge	2	10.5
Step(break/snap)	8	42.1
Retouched	2	10.5
Total	**19**	**100.0**

Table 151 - Unit S2 – Shanidar Layer D4c – Flake termination: whole and broken flakes

6.6.9.2 Pointedness

The reason for recording pointed flakes was in order to see if a conscious choice of producing pointed blanks/debitage could be recognised. A pointed flake is defined here as a flake blank pointed either through detachment, or by a snap, or by retouch. These three definitions are arguably each discrete techno-functional types, i.e. technological decisions prompted by separate or related behavioural adaptive motives. Consequently, each of these three manifestations really warrant discrete treatment. A flake pointed by detachment might be fortuitous, a flake pointed by a snap might be considered to be purposefully transformed, and a flake (seemingly) pointed by retouch might indeed be purposefully transformed, or through use and/or rejuvenation might have been altered in a way so as to leave the discarded flake with the typological appearance of a "purposeful-looking" shape. Unfortunately, with the methodological approach of mainly looking at whole flakes, this particular techno-typological trait is difficult to decipher, as the manifestation of a pointed blank transcends the flake assemblage and can be expressed both in whole flakes, in any expression of broken flake such a s proximal, medial, and distal, and also as a retouched piece.

Pointed blanks occur in all three sub-layers (tables 152-154), but not in a pattern as to justify further examination.

Pointed flakes	Frequency	Percent
YesDebitage	1	5.9
YesRetouch	3	17.6
No	13	76.5
Total	**17**	**100.0**

Table 152 - Unit S2 – Shanidar Layer D4a – Pointed flakes

Pointed flakes	Frequency	Percent
YesDebitage	5	26.3
YesRetouch	1	5.3
No	13	68.4
Total	**19**	**100.0**

Table 153 - Unit S2 – Shanidar Layer D4b – Pointed flakes

Pointed flakes	Frequency	Percent
YesDebitage	1	11.1
No	8	88.9
Total	**9**	**100.0**

Table 154 - Unit S2 – Shanidar Layer D4c – Pointed flakes

6.6.9.3 Typology

Revisiting the change to the organisation of the structure of the data classes based on the assemblage, the typological make-up of the flake population is as follows: Flakes are classified based on presence or absence of retouch. Flakes are further divided between tools, multi-tools, non-tools, and core-on-flakes/truncated-facetted pieces (tables 155-157).

Data class	Frequency	Percent
RetouchedFlake	1	5.9
UnretouchedFlake	10	58.8
Tool	5	29.4
Multi-Tool	1	5.9
Total	**17**	**100.0**

Table 155 - Unit S2 – Shanidar Layer D4a – Data class: whole flakes

Data class	Frequency	Percent
RetouchedFlake	4	21.1
UnretouchedFlake	14	73.7
Tool	1	5.3
Total	**19**	**100.0**

Table 156 - Unit S2 – Shanidar Layer D4b – Data class: whole flakes

Data class	Frequency	Percent
RetouchedFlake	1	11.1
UnretouchedFlake	8	88.9
Total	**9**	**100.0**

Table 157 - Unit S2 – Shanidar Layer D4c – Data class: whole flakes

6.6.9.4 Retouched and Unretouched Flakes to Tools

Layer D4a is interesting because 1/3 of the whole flake assemblage can be classified as tools, with just around 60% assigned as unretouched (non-tool) flakes. This proportion decreases through layer D4b to D4c.

If broken flakes are included, the unretouched (non-tool) component drops with 15% compared to retouched flakes and formal tools, resulting in more formal than informal pieces in layer D4a (tables 158-160). A lesser decline is evident for the two other layers.

Data class	Frequency	Percent
CoreOnFlake	2	4.9
RetouchedFlake	10	24.4
UnretouchedFlake	19	46.3
Tool	8	19.5
Multi-Tool	2	4.9
Total	**41**	**100.0**

Table 158 - Unit S2 – Shanidar Layer D4a – Data class: whole and broken flakes

Data class	Frequency	Percent
RetouchedFlake	9	22.0
UnretouchedFlake	29	70.7
Tool	3	7.3
Total	**41**	**100.0**

Table 159 - Unit S2 – Shanidar Layer D4b – Data class: whole and broken flakes

Data class	Frequency	Percent
CoreOnFlake	1	5.3
RetouchedFlake	2	10.5
UnretouchedFlake	15	78.9
Tool	1	5.3
Total	**19**	**100.0**

Table 160 - Unit S2 – Shanidar Layer D4c – Data class: whole and broken flakes

6.6.9.5 Tool types

Only a few different tool types are identified across the assemblages. Scrapers and burins are the most common, with notches and borers also present. To what extent Mousterian points are functionally different from convergent scrapers is beyond the scope of this study. Both types will here be considered as close functionally as they are close typologically.

Layer D4a is shown above to be much richer in tools than the other two layers. The tool inventory is not particularly diverse. It is divided between scrapers/Mousterian points and burins (Table 161). In contrast, layer D4b (Table 162) has one burin. There are no whole tools from layer D4c.

Looking at both whole and broken tools the variability of the formal tools stay the same (tables 163-165).

Tool type	Frequency
Convergent Scraper	1
Burin	2
Mousterian Point	2
Single Scraper and Burin	1
Total	**6**

Table 161 - Unit S2 – Shanidar Layer D4a – Tool type: whole flakes

Tool type	Frequency
Burin	1

Table 162 - Unit S2 – Shanidar Layer D4b – Tool type: whole flakes

Tool type	Frequency
Single Scraper	1
Convergent Scraper	2
Burin	2
Mousterian Point	2
Single Scraper and Burin	1
Burin and Notch	1
Borer/Bec/Priser	1
Total	**10**

Table 163 - Unit S2 – Shanidar Layer D4a – Tool type: whole and broken flakes

Tool type	Frequency
Burin	3

Table 164 - Unit S2 – Shanidar Layer D4b – Tool type: whole and broken flakes

Tool type	Frequency
Burin	1

Table 165 - Unit S2 – Shanidar Layer D4c – Tool type: whole and broken flakes

6.6.10 Levallois

6.6.10.1 Levallois by layer whole/broken

Levallois is present in all three layers of the Shanidar Layer D4 assemblage (tables 166-168). It is higher among whole flakes than among broken flakes (tables 169-171). This might be due to the difficulty of identifying Levallois products among broken flakes, and therefore should not be taken to suggest any behavioural signal.

Levallois	Frequency	Percent
Yes	5	29.4
No	12	70.6
Total	17	100.0

Table 166 - Unit S2 – Shanidar Layer D4a – Levallois: whole flakes

Levallois	Frequency	Percent
Yes	4	21.1
No	15	78.9
Total	19	100.0

Table 167 - Unit S2 – Shanidar Layer D4b – Levallois: whole flakes

Levallois	Frequency	Percent
Yes	3	33.3
No	6	66.7
Total	9	100.0

Table 168 - Unit S2 – Shanidar Layer D4c – Levallois: whole flakes

Levallois	Frequency	Percent
Yes	7	17.1
No	34	82.9
Total	41	100.0

Table 169 - Unit S2 – Shanidar Layer D4a – Levallois: whole and broken flakes

Levallois	Frequency	Percent
Yes	7	17.1
No	34	82.9
Total	41	100.0

Table 170 - Unit S2 – Shanidar Layer D4b – Levallois: whole and broken flakes

Levallois	Frequency	Percent
Yes	4	21.1
No	15	78.9
Total	19	100.0

Table 171 - Unit S2 – Shanidar Layer D4c – Levallois: whole and broken flakes

6.6.10.2 Levallois by data class

The Levallois component is two thirds whole flakes (tables 172-177). As mentioned above, this might be misleading due to the possibility of misidentification of broken Levallois flakes. Within the group of whole Levallois flakes unretouched pieces are most common.

Data class	Frequency	Percent
UnretouchedFlake	2	40.0
Tool	3	60.0
Total	**5**	**100.0**

Table 172 - Unit S2 – Shanidar Layer D4a – Levallois Data class: whole flakes

Data class	Frequency	Percent
UnretouchedFlake	4	100.0

Table 173 - Unit S2 – Shanidar Layer D4b – Levallois Data class: whole flakes

Data class	Frequency	Percent
UnretouchedFlake	3	100.0

Table 174 - Unit S2 – Shanidar Layer D4c – Levallois Data class: whole flakes

Data class	Frequency	Percent
UnretouchedFlake	3	42.9
Tool	4	57.1
Total	**7**	**100.0**

Table 175 - Unit S2 – Shanidar Layer D4a – Levallois Data class: whole and broken flakes

Data class	Frequency	Percent
UnretouchedFlake	5	71.4
RetouchedFlake	2	28.6
Total	**7**	**100.0**

Table 176 - Unit S2 – Shanidar Layer D4b – Levallois Data class: whole and broken flakes

Data class	Frequency	Percent
UnretouchedFlake	3	75.0
Tool	1	25.0
Total	**4**	**100.0**

Table 177 - Unit S2 – Shanidar Layer D4c – Levallois Data class: whole and broken flakes

6.6.10.3 Type of Levallois products

Looking at the techno-typological makeup of the Levallois flakes, most of the conventional types are present (tables 178-180). There does not seem to be any particular dominance of any single typological product. A single point is identified in layer D4a, but whether the absence of points in the other two layers is due to behavioural or taphonomic processes or simply a question of constraint of sample size is not immediately recognisable.

Type	Frequency	Percent
Point	1	20.0
Blade	1	20.0
DebordantAndOvershot	1	20.0
indeterminate	2	40.0
Total	**5**	**100.0**

Table 178 - Unit S2 – Shanidar Layer D4a – Type of Levallois product in morphological terms: whole flakes

Type	Frequency	Percent
Flake	3	75.0
Blade	1	25.0
Total	**4**	**100.0**

Table 179 - Unit S2 – Shanidar Layer D4b – Type of Levallois product in morphological terms: whole flakes

Type	Frequency	Percent
Flake	2	66.7
DebordantFlake	1	33.3
Total	**3**	**100.0**

Table 180 - Unit S2 – Shanidar Layer D4c – Type of Levallois product in morphological terms: whole flakes

6.6.10.4 Levallois tool types

The tool types identified in the Levallois part of the assemblage are scrapers, burins, and Mousterian points. Except for one burin in Level D4c, all tools are from layer D4a (tables 181 and 183). As mentioned above, whether Mousterian points are to be treated as convergent scrapers is a moot point. In any case, the convergent configuration dominates the tool types. Tables 182 and 184 shows the type of Levallois product used as tool blanks. It would appear that no difference in tool types exists between tools made on Levallois blanks and tools made on non-Levallois blanks (tables 185-186).

Tool type	Frequency
Convergent Scraper	1
Burin	1
Mousterian Point	2
Total	**4**

Table 181 - Unit S2 – Shanidar Layer D4a –Tool type: whole and broken flakes

		Tool Type		
		Convergent Scraper	Burin	Mousterian Point
		Count	Count	Count
Type of Levallois Product in Morphological terms	Flake	0	0	0
	Point	0	0	**1**
	Blade	0	0	0
	DebordantFlake	0	0	0
	Overshot	0	0	0
	DebordantAndOvershot	0	0	0
	indeterminate	**1**	**1**	**1**
	Total	**1**	**1**	**2**

Table 182 - Unit S2 – Shanidar Layer D4a – Tool type by type of Levallois product in morphological terms: whole and broken flakes

Tool type	Frequency
Burin	1

Table 183 - Unit S2 – Shanidar Layer D4c –Tool type: whole and broken flakes

		Tool Type
		Burin
		Count
Type of Levallois Product in Morphological terms	**Flake**	**1**
	Point	0
	Blade	0
	Debordant Flake	0
	Overshot	0
	Debordant and Overshot	0
	indeterminate	0
	Total	**1**

Table 184 - Unit S2 – Shanidar Layer D4c – Tool type by type of Levallois product in morphological terms: whole and broken flakes

		Tool Type		
		Convergent Scraper	Burin	Mousterian Point
		Count	Count	Count
Typology	Levallois Flake	1	1	0
	Levallois Point	0	0	2

Table 185 - Tools on Levallois blanks: Typology by tool type

		Tool Type					
		Single Scraper	Convergent Scraper	Burin	Single Scraper and Burin	Burin and Notch	Borer/Bec
		Count	Count	Count	Count	Count	Count
Typology	Flake	0	1	0	1	0	0
	Broken Flake	1	0	0	0	1	1
	Metrical Blade	0	0	1	0	0	0

Table 186 - Tools on non-Levallois blanks: Typology by tool type

6.6.10.5 Number of preceding Levallois removals

Evidence for preceding Levallois removals (as identified by dorsal scar pattern on Levallois flakes) is identified throughout the three sub-layers (tables 187-190). This would seem to indicate a similar approach to producing Levallois blanks across the three sub-layers.

No. of preceding Levallois removals	Frequency
1	3

Table 187 - Unit S2 – Shanidar Layer D4a – Number of preceding Levallois removals

No. of preceding Levallois removals	Frequency
1	1

Table 188 - Unit S2 – Shanidar Layer D4b – Number of preceding Levallois removals

No. of preceding Levallois removals	Frequency
1	2

Table 189 - Unit S2 – Shanidar Layer D4c – Number of preceding Levallois removals

					Type of Levallois Product in Morphological Terms						
					Flake	Point	Blade	Debordant Flake	Overshot	Debordant and Overshot	Indeterminate
					Mean	Mean	Mean	Mean	Mean	Mean	Mean
Cut	D-7	Spit	7.00-7.25	NPLR	.	.	.	.	.	.	.
			7.20-7.75	NPLR	.	.	.	.	.	.	.
			7.25-7.50	NPLR	.	.	.	.	.	.	.
			7.50-7.75	NPLR	.	.	1	.	.	.	.
			7.75-8.00	NPLR	.	1	.	.	.	1	.
			8.00-8.25	NPLR	.	.	.	.	.	.	.
			8.25-8.50	NPLR	.	.	.	.	.	.	.
			8.75-9.00	NPLR	1	.	.	1	.	.	.
	D-8	Spit	7.00-7.25	NPLR	.	.	.	.	.	.	.
			7.20-7.75	NPLR	.	.	.	.	.	.	.
			7.25-7.50	NPLR	.	.	.	.	.	.	.
			7.50-7.75	NPLR	.	.	.	.	.	.	.
			7.75-8.00	NPLR	.	.	.	.	.	.	.
			8.00-8.25	NPLR	.	.	.	.	.	.	.
			8.25-8.50	NPLR	1	.	.	.	.	.	.
			8.75-9.00	NPLR	.	.	.	.	.	.	.

Table 190 - Number of preceding Levallois removals (NPLR) by type of Levallois product in morphological terms, by cut and spit

6.6.10.6 Mode of preparation

Mode of preparation is mostly centripetal, where identifiable (tables 191-193). This might be a logical consequence of reduction dynamics, through which a core will get progressively smaller during preparation and repreparation, forcing the knapper to adopt a centripetal reduction scheme as operational choice for flake detachment is reduced.

6.6.10.7 Mode of exploitation

Following from the above description of mode of preparation, mode of exploitation is overwhelmingly recurrent (tables 194-196).

Mode of preparation	Frequency	Percent
Bipolar	1	20.0
Centripetal	1	20.0
Indeterminate	3	60.0
Total	**5**	**100.0**

Table 191 - Unit 2 – Shanidar Layer D4a – Mode of preparation

Mode of preparation	Frequency	Percent
Centripetal	3	75.0
Indeterminate	1	25.0
Total	**4**	**100.0**

Table 192 - Unit 2 – Shanidar Layer D4b – Mode of preparation

Mode of preparation	Frequency	Percent
Centripetal	2	66.7
Indeterminate	1	33.3
Total	**3**	**100.0**

Table 193 - Unit S2 – Shanidar Layer D4c – Mode of preparation

Mode of preparation	Frequency	Percent
UnipolarRecurrent	1	20.0
BipolarRecurrent	2	40.0
Indeterminate	2	40.0
Total	5	100.0

Table 194 - Unit S2 – Shanidar Layer D4a – Mode of exploitation

Mode of preparation	Frequency	Percent
Lineal	1	25.0
UnipolarRecurrent	1	25.0
Indeterminate	2	50.0
Total	4	100.0

Table 195 - Unit S2 – Shanidar Layer D4b – Mode of exploitation

Mode of preparation	Frequency	Percent
UnipolarRecurrent	1	33.3
CentripetalRecurrent	1	33.3
Indeterminate	1	33.3
Total	3	100.0

Table 196 - Unit S2 – Shanidar Layer D4c – Mode of exploitation

6.6.10.8 Evidence of repreparation

Curiously, no evidence of repreparation was identified (tables 197-199). This is surprising considering the evidence for recurrent exploitation mentioned above.

Evidence of preparation	Frequency	Percent
No	5	100.0

Table 197 - Unit S2 – Shanidar Layer D4a – Evidence of repreparation

Evidence of preparation	Frequency	Percent
No	4	100.0

Table 198 - Unit S2 – Shanidar Layer D4b – Evidence of repreparation

Evidence of perparation	Frequency	Percent
No	3	100.0

Table 199 - Unit S2 – Shanidar Layer D4c – Evidence of repreparation

6.6.11 Discussion of the Shanidar Layer D4 assemblage

In this summary of the Shanidar Layer D lithics, I will recapitulate the issues besetting the assemblage and argue for the specific synthesising leading to the amalgamation of sub-layers D4a, D4b, and D4c from cuts D-7 and D-8 into one operational dataset: Unit S2, to be used in comparative analysis with the other site assemblages included in this thesis.

Through a detailed stratigraphic analysis of the cuts and spits, it was possible to separate out contextual units of spatio-temporal diversity across the cuts and spits within the overall excavation. This was done following the work of Solecki and Solecki (1993), and their definition of the sub-layers within Layer D as a guideline. Through careful analyses, parts of the three sub-layers of Layer D4 – D4a, D4b, and D4c – were disentangled to a degree so as to confidently carry out contextual attribute analyses, leading to a comparative breakdown of the three sub-layers and their individual characteristics. This led to the recognition that although some inherent variability can be said to be present, the three sub-layers share a sufficient amount of taphonomic, spatial, synchronic, and techno-typological affinities that they can confidently be amalgamated into one operational assemblage for the purpose of comparative assessment. For this reason, the sub-assemblages labelled sub-layers D4a, D4b, and D4c, of cuts D-7 and D-8, will be treated as one assemblage: Unit S2.

6.6.12 Raw material sourcing and taphonomy

No dedicated sourcing of raw material was carried out for this study. Raw material is constituted mainly of flint/chert of various colour, similar in range to the assemblages analysed from Houmian and Warwasi. It is assumed raw material were sourced from the river gravel and terraces around the Greater Zab River, ca. 3 kilometres (Reynolds et al. 2018:745) down the valley.

6.6.13 Core to flake correlation, on-site core reduction, and flake modification

As only three unprepared cores were available for study, the correlation between core and flake sizes must be assumed to be tentative. However, although two of the three cores are from cuts outside Unit S2 (C-8 and B-7), those three cores are all from contexts within a single spit of sub-layer D4a. For this reason, a correlation to the Unit S2 flake assemblage is warranted. The cores are all very small at 30 mm, 24 mm, and 22 mm, for length, width, and thickness, respectively. One is discoidal, and two have been worked on an *ad hoc* basis before discard. The largest scar left on the cores are about 15 mm for length and width. As two of the three cores were retaining some cortex on the surface, it is assumed here that discard was effectuated when the size of viable flakes became too small. Besides the three nodule cores, four core-on-flakes were identified in this assemblage.

The flake component from Unit S2 have mean length, width, and thickness of 29 mm, 22 mm, and 6 mm, respectively. While this does not exclude the flakes from Unit S2 being produced through core reduction involving the three cores mentioned above, their small number considered cannot work as an outright confirmation either.

The relatively low number of dorsal scar counts, combined with an almost equal distribution between earlier and later stage reduction proxies by way of dorsal scar patterns (with a slight dominance of simple patterns over more complex patterns), is taken to suggest later stage reduction of small cores, as hinted by the size of the three analysed cores. This is corroborated by dorsal cortex signatures. To reiterate the interpretation from above, the signature of non-complex dorsal scar patterns could in this context be taken to suggest later stage reduction of small cores, where core rotation, or platform migration, was not possible, thereby reducing the amount of possibility for complex patterns. This also seems supported by the low number of redirection flakes, and the variability displayed by butt types.

6.6.14 Retouch intensity and tool types

Looking at the available material to try judging the proxies for retouch intensity, of the overall flake assemblage of Unit S2, there is a preponderance for retouched or modified pieces. 33% of the flakes in Unit S2 are retouched. 68% of those retouched flakes display invasive retouch and 32% exhibit stepped retouch. These two categories of retouch are considered proxies for retouch intensity. 29% of the retouched flakes display invasive and stepped retouch together. This might possibly be an artifact of curation by the excavators, but this cannot be confirmed.

It was very unfortunate that most of the retouched tool assemblage (Solecki and Solecki 1993) were not available for this study. This precludes any definitive inferences about blank selection, blank modification, tool preference, and retouch intensity with Unit S2 of the Shanidar Layer D deposit.

As it is impossible to know to what extent the Shanidar Layer D assemblage was skewed in terms of curational preferences by the excavator, it is impossible to know whether the absence in this study of the majority of the so-called "pointed tools" (believed to be part of the Columbia University collection now in the Smithsonian) make up for such potential skewness. It would be imprudent to attribute too much interpretive value to the information provided by the available retouched assemblage in this regard.

On the contrary, while heavily retouched pointed tools have always been favoured in heavily curated assemblages, so as to lead to an assumption such artefacts were more prolific in specific contexts than is actually true, other typological pieces can be thought to portray a more accurate picture. Cores-on-flakes and truncated-facetted pieces should not be expected to have been necessarily curated to the extent apparent for heavily retouched pointed tools. For this reason, cores-on-flakes and truncated-facetted pieces can be assumed to show a truer picture of their relative distribution within the site. This is positive, as will be discussed below, as truncated-facetted pieces (and cores-on-flakes) are one of the main proxies used by Lindly (1997) to argue for the vertical mobility strategy claimed to be part of the evidence for his summer occupation model in the Zagros. Unit S2 provide evidence for single and convergent scrapers, and Mousterian points as well as burins.

6.6.15 Evidence for Levallois technology and reduction within Shanidar Unit S2

Shanidar Unit S2 have 18% Levallois. Levallois is more common in the whole flake assemblage than within the broken flake assemblage. The reason for this might possibly be that identification of Levallois is harder among broken pieces. A behavioural explanation could be that tools made through Levallois would be transported off-site to be used in the landscape, and if broken, discarded in the landscape rather than being brought back.

Whole flakes constitute 67% of the Levallois component. And of whole Levallois flakes, the most common is unretouched pieces.

Only one Levallois point is present in the Unit S2 assemblage. This is more likely a behavioural signal, rather than a curational, since Levallois points, due to their typological distinctiveness, are more easily spotted during excavation, and historically were more coveted by excavators. Beside the single Levallois point, both Levallois blades and flakes are present.

The tool types identified in the Levallois part of the assemblage are scrapers, burins, and Mousterian points. Convergent tools dominate. There does not exist a positive correlation between anyone tool type and Levallois blanks. Mode of preparation is mostly centripetal and mode of exploitation is almost exclusively recurrent.

6.6.16 Major insights to hominin behaviour at Shanidar based on data analysis

Seeing Shanidar as part of a vertical mobility strategy, such as proposed by Lindly (1997), technological clues in the form of radial cores and truncated-facetted pieces (and core-on-flakes) are relevant. Of the three cores available, one is discoidal, and four cores-on-flakes were identified in Unit S2. Although the sample size is small, it is more or less exactly the same size as Lindly's (1997: 348), where his 170 pieces only included one core. Further, as Lindly categorise truncated-facetted pieces (or truncated facetted cores, as he calls them) within his data class, as cores, not as flakes, apparently, no truncated-facetted pieces were identified by him at Shanidar (Lindly 1997: 247-261). Based on the findings in this study, and although I identify more flakes used as cores (4 core-on-flakes, of which 2 is identified as truncated-facetted pieces) than does Lindly (who identifies 0, 1997), the population of 4% hardly would qualify as a determining factor when arguing for the characteristic use of flakes as cores in a vertical mobility strategy. But since Shanidar, at 745 m a.s.l., technically figure as one of the "lower" sites in Lindly's study (1997: 345), and since either Lindly or this study had access to any substantial core assemblage, the amount of "radial"/centripetal cores to truncated-facetted pieces (core-on-flakes) cannot be estimated. It is therefore difficult to validate whether Shanidar, based solely on the dichotomy of "radial"/centripetal cores to truncated-facetted pieces, would help substantiate the "summer adaptation hypothesis" or not.

6.7 Summary of discussion of Shanidar Layer D4 data analysis

Raw material sourcing

- Dedicated raw material sourcing was not carried out. Assumption is that raw material was likely sourced by hominins by or around the greater Zab River, and *en route* to the cave.

Core to flake correlation, on-site core reduction, and flake modification

- Tentative correlation of cores and flakes within the assemblage. One discoidal core is present (4 core-on-flakes identified). Cores are assumed to have been discarded when potential size of flakes became too small.
- Later stage reduction of small cores
- No “radial”/centripetal cores

Retouch intensity and tool types

- Prevalence of retouched or modified pieces in the Unit S2 assemblage.
- Large part of retouched tools was not available for this study.
- Evidence for single and convergent scrapers, Mousterian points as well as burins.

Evidence for Levallois technology and reduction at Shanidar

- Shanidar Unit S2 have 18% Levallois.
- Levallois is more common in the whole flake assemblage than within the broken flake assemblage.
    - Possible off-site use of Levallois flakes
- 67% of Levallois component is whole flakes.
    - Unretouched pieces most common.
- Only one Levallois point
    - Likely a behavioural signal
- Centripetal preparation and recurrent exploitation

Major insights to hominin behaviour at Shanidar based on data analysis

- The analysis of the Shanidar Unit S2 material seems to corroborate some of the points of previous interpretations (Skinner 1965; Lindly 1997) of the Shanidar Layer D assemblage as a “Zagros Mousterian” industry.
- Due to the absence of known Layer D material, the interpretative value from the above analyses must be concluded to be tentative.

Chapter 7 - Warwasi data analysis

7.1 Research history

The multiperiod-Palaeolithic Warwasi rockshelter, which produced one of the most important sequences yet found in the Zagros, was never fully published by its 1960 excavator, Bruce Howe (Braidwood 1960; Braidwood 1961; Braidwood et al. 1961), and its lithic industries remained virtually unknown for decades.

In the early 1980s, Harold Dibble (1984a, b) studied and re-interpreted the Middle Palaeolithic assemblage from the nearby Bisitun Cave housed in the University Museum of Archaeology and Anthropology at the University of Pennsylvania. Bisitun Cave had been excavated in 1949 by Carlton Coon (1951, 1957), and the Mousterian occupation was the only material found there (cf. Movius in Coon 1951: 92). Despite Coon's self-declared lack of proficiency in lithic analysis, and while trusting a more thorough study of the stone tools to his colleague, Hallam L. Movius (in Coon 1951: 91-92), which never materialised, he did publish a, for the times, fairly detailed description of the lithics (Coon 1951: 53-65). Unfortunately, Coon chose to adopt his own stone tool nomenclature in his description, rendering it essentially in-operational for other researchers. Skinner (1965: 59-62) was the first to introduce a more palatable account of the Bisitun material, grounded in the new Bordesian framework (Bordes 1961) into a broader research of the field in his work on the Zagros Mousterian.

Two extremely important findings were born out of Dibble's reappreciation of the Bisitun assemblage. Most significantly for the field in general, it was through working on the Bisitun scrapers his ideas for the paradigm-changing view on stone tool typology, that typological types could instead be viewed as stages along a retouch continuum, developed (1984a, b, 1987, 1995).

Crucially for the study of the Zagros Mousterian, Dibble's discovery that the Bisitun industry contained a significant amount of Levallois technology contradicted Skinner's (1965) findings, and seriously challenged the validity of his Group A – the Zagros Mousterian (1965: 135-143, 192-200), as a homogenous entity when compared to other traditional regions of Mousterian variability, like the Levant, and Southwestern France. That Skinner seemingly had overlooked this circumstance initially, encouraged Dibble to pursue the question of whether more work on other Zagros assemblages could prove that the Middle Palaeolithic of this highland area could disclose additional inter-site variability, possibly leading to a refutal of the Zagros Mousterian as a distinct techno-behavioural expression, or perhaps show that the Bisitun Middle Palaeolithic material was just an anomaly within an otherwise homogenous "techno-complex"

7.1.1 Curatorial history

The lithic collections from the Warwasi excavation were transferred on a permanent loan by Robert Braidwood, from the Oriental institute of the University of Chicago, to the University Museum of Archaeology and Anthropology, University of Pennsylvania, in the late 1980s (Holdaway 1989:82). Work by Dibble and his students (Holdaway 1989; Dibble and Holdaway 1990; papers in Olszewski and Dibble 1993), on the Warwasi assemblages were presented, together with other new studies on the Palaeolithic of the Zagros, at a dedicated symposium at the Society for American Archaeology meetings in Las Vegas in 1990 (Olszewski and Dibble 1993: xiii). The complete Middle Palaeolithic assemblage constitutes ca. 4350 pieces (Harold Dibble and Celina Candrella, pers. comm.).

7.1.2 Excavation

Bruce Howe chose the northern edge of the rockshelter to sink his trench, which was approximately 8 x 1-2 m in size, approaching a triangular shape (Olszewski 1993a: 187; Olszewski 1993b: 207), and reaching a depth of 5.6 m (Dibble and Holdaway 1993: 75; cf. Tsanova 2013: 42) (Figure 68). It is unclear from the literature whether the sounding reached bedrock. It was not possible for the excavation team to identify any geomorphological boundaries within the stratigraphy, and for that reason the excavation was conducted in 10 cm spits. All spits, referred to as levels, were 10 cm in depth except for levels B (ca. 20 cm) and R (ca. 15 cm). 55 levels (A-Z, AA-ZZ, and AAA-CCC) were recorded, with CCC being the lowermost level. No chronometric dates exist for Warwasi (Tsanova 2013:42).

While initially there were some uncertainties with regard to the identification of where in the sequence the Middle Palaeolithic ended, and the Upper Palaeolithic begun (Dibble and Holdaway 1993: 75), there is now a broad consensus. The Middle Palaeolithic sequence runs from the bottommost level CCC through level NN (Olszewski and Dibble 1994: 68-69; Otte and Kozlowski 2007: 40, figure 6; Tsanova 2013:42). The Upper Palaeolithic sequence has been divided into an Earlier and Later Zagros Aurignacian (sensu Olszewski 1993), or Earlier and Later Baradostian (sensu Otte and Kozlowski 2007). The earlier sequence is identified from levels LL through AA, and the later sequence from level Z through level P. Levels O to A are Epi-Palaeolithic Zarzian (Tsanova 2013).

7.1.3 Sampling method and assemblage composition of the lithics

7.1.3.1 Warwasi WWXX sample unit

As my sample assemblage of the Warwasi Middle Palaeolithic (tables 200-206) is not large enough to offer a replication of the work done by Dibble and Holdaway (1993), I have chosen to create an arbitrary unit by pooling my two largest sample levels, WW (N=224) and XX (N=168) (Table 207) (see Appendix plates 21-30). I considered and rejected the possibility of analysing all my 14 sample levels as one unit, due to the lack of chrono-stratigraphical control afforded by the published literature. By selecting just two levels from within a 20 cm total horizontal boundary, the assumption is that more reliable insights about, albeit somewhat delimited, site-use can be gained.

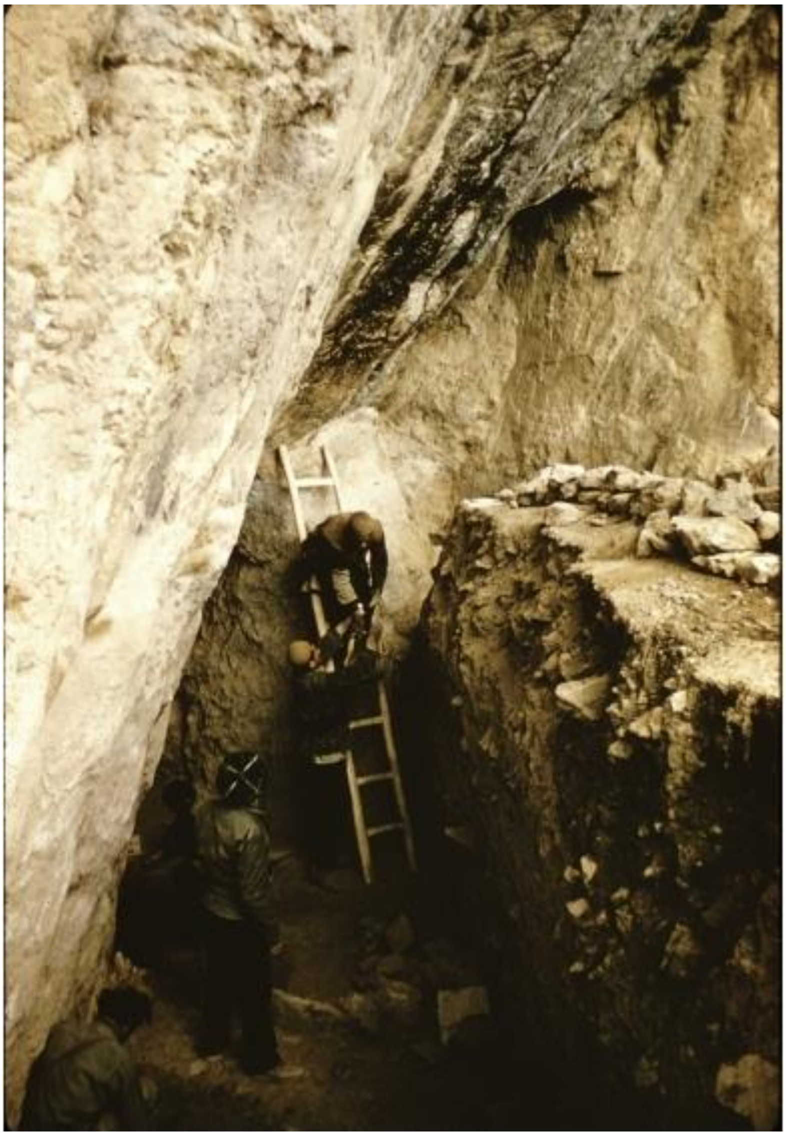

Figure 68 - Warwasi rockshelter under excavation 1960 (Photo: Frank Hole) from Tsanova 2013.

Level	Frequency	Percent
PP	15	2.5
QQ	9	1.5
RR	16	2.7
SS	15	2.5
TT	19	3.2
UU	33	5.5
VV	23	3.8
WW	224	37.1
XX	168	27.9
YY	12	2.0
ZZ	9	1.5
AAA	32	5.3
BBB	19	3.2
CCC	9	1.5
Total	**603**	**100.0**

Table 200 - Warwasi total sample by 10 cm spit (level)

	Frequency	Percent
Core	98	16.3
CoreOnFlake	72	11.9
RetouchedFlake	150	24.9
UnretouchedFlake	243	40.3
Tool	39	6.5
Multi-Tool	1	.2
Total	**603**	**100.0**

Table 201 - Warwasi total sample by data class (total sample by 10 cm spit) (level)

		Frequency	Percent
Valid	PP	9	9.2
	QQ	3	3.1
	RR	9	9.2
	SS	9	9.2
	TT	15	15.3
	UU	14	14.3
	VV	5	5.1
	WW	8	8.2
	XX	7	7.1
	YY	7	7.1
	ZZ	8	8.2
	AAA	2	2.0
	BBB	1	1.0
	CCC	1	1.0
	Total	98	100.0

Table 202 - All Warwasi cores by 10 cm spits (level)

Type of Levallois preparation	Frequency	Percent
Yes	39	39.8
Simple	10	10.2
No	49	50.0
Total	**98**	**100.0**

Table 203 - All Warwasi prepared (Levallois), simple-prepared (Levallois), and unprepared cores

Spit	Levallois Yes Count	Simple Count	No Count
PP	4	0	5
QQ	0	1	2
RR	3	3	3
SS	5	1	3
TT	4	2	9
UU	5	0	9
VV	2	0	3
WW	6	1	1
XX	1	0	6
YY	4	1	2
ZZ	4	0	4
AAA	1	0	1
BBB	0	1	0
CCC	0	0	1
Subtotal	**39**	**10**	**49**

Table 204 - All Warwasi cores by preparation type by spit (Level)

Core on flakes by preparation	Frequency	Percent
Yes	3	4.2
Simple	4	5.6
No	65	90.3
Total	**72**	**100.0**

Table 205 - All Warwasi core-on-flakes by preparation

Spit	Frequency	Percent
PP	5	6.9
QQ	6	8.3
RR	7	9.7
SS	6	8.3
TT	4	5.6
UU	10	13.9
VV	1	1.4
WW	15	20.8
XX	16	22.2
AAA	2	2.8
Total	**72**	**100.0**

Table 206 - All Warwasi core-on-flakes by spit

Data class	Frequency	Percent
Core	15	3.8
CoreOnFlake	31	7.9
RetouchedFlake	95	24.2
UnretouchedFlake	219	55.9
Tool	31	7.9
Multi-Tool	1	.3
Total	**392**	**100.0**

Table 207 - Warwasi level WWXX by data class

7.1.3.2 Taphonomic assessment

Due to similar constraints imposed on this collection by the housing institution, as experienced for the studies of the two previous chapters, no dedicated taphonomic study was possible to carry out. However, a simple visual assessment established that the material chosen for the combined unit WWXX were of broadly similar post-depositional condition, so as to be taken to constitute a coherent body.

7.1.3.4 Thermal alteration and Recycling

With no stratigraphic or piece-plotting information available, the artefacts identified showing traces of thermal alteration and/or recycling cannot be further pursued for spatial analysis. One retouched flake preserved evidence of both thermal alteration and recycling (tables 208-209).

				Thermal alteration	
				No	Yes
				Count	Count
Level	WW	DataClass	Core	8	0
			CoreOnFlake	15	0
			RetouchedFlake	52	1
			UnretouchedFlake	127	3
			Tool	17	0
			Multi-Tool	1	0
			Subtotal	**220**	**4**
	XX	DataClass	Core	5	2
			CoreOnFlake	16	0
			RetouchedFlake	40	2
			UnretouchedFlake	88	1
			Tool	14	0
			Multi-Tool	0	0
			Subtotal	**163**	**5**

Table 208 - Warwasi level WWXX: Thermal alteration

				Recycled	
				No	Yes
				Count	Count
Level	WW	DataClass	Core	8	0
			CoreOnFlake	15	0
			RetouchedFlake	52	1
			UnretouchedFlake	127	3
			Tool	15	2
			Multi-Tool	1	0
			Subtotal	**218**	**6**
	XX	DataClass	Core	7	0
			CoreOnFlake	16	0
			RetouchedFlake	41	1
			UnretouchedFlake	88	1
			Tool	14	0
			Multi-Tool	0	0
			Subtotal	**166**	**2**

Table 209 - Warwasi level WWXX: Recycled pieces

7.2 Cores

While the arbitrary Warwasi levels in general, and my sample of them in particular, cannot be assumed to represent any original delimited deposit, it is at least curious that almost all cores in level WW are prepared cores and almost all cores in level XX are unprepared (Table 210). 15 cores are included in my WWXX unit, constituting about 4% of the total WWXX assemblage. In the description of the non-nodule-core assemblage below, the portion of the flake assemblage turned into core blanks, core-on-flakes or truncated facetted pieces, will be described.

Where identifiable, the cores are mostly made on nodules. These are likely to be river pebbles, either picked up from near a water source, or found eroded out of terraces. Blank form has not been retained on any of the cores (table 211).

7.2.1 Core assemblage size by level, blank type, and dimensions

Although the core assemblage is too small to permit a robust statistical breakdown, a few patterns could arguably be put forward. The sample size notwithstanding, the range between minimum and maximum length of prepared cores is much more restricted than for unprepared cores (tables 212-214). Now, while this could have several parsimonious explanations, a behavioural reason for such manifestation could be a preferred size of flake blanks in prepared core reduction, or simply the inability to re-configure the flake-release surface satisfactorily after a number of successful reduction sequences.

Mean proportions for prepared cores are 39 mm for length, 38 mm for width, and 18 mm for thickness. For unprepared cores, mean proportions are 44 mm for length, 36 mm for width, and 24 mm for thickness. This furnishes a combined mean for length, width, and thickness of ca. 4 cm, ca. 4 cm, and ca. 2 cm, respectively.

					Levallois
		Yes	Simple	No	Subtotal
		Count	Count	Count	Count
Level	WW	6	1	1	**8**
	XX	1	0	6	**7**

Table 210 - Warwasi level WWXX: cores by preparation type by level

	Frequency	Percent
Indeterminate	3	37.5
Nodule	3	37.5
ShatteredNodule	1	12.5
ThermalFrostflake	1	12.5
Total	**8**	**100.0**

Table 211 - Warwasi level WWXX: core blanks by blank type

	N	Minimum	Maximum	Mean
MaxLength	15	14.00	90.42	41.3320
MaxWidth	15	16.96	60.20	37.1167
MaxThickness	15	10.00	57.11	20.5320

Table 212 - Warwasi level WWXX: Max length, width, and thickness for all cores.

	N	Minimum	Maximum	Mean
MaxLength	7	14.00	90.42	43.8000
MaxWidth	7	16.96	60.20	36.4871
MaxThickness	7	10.00	57.11	23.7229

Table 213 - Warwasi level WWXX: Max length, width, and thickness for unprepared cores.

	N	Minimum	Maximum	Mean
MaxLength	8	30.00	58.90	39.1725
MaxWidth	8	23.43	58.80	37.6675
MaxThickness	8	13.20	26.15	17.7400

*Table 214 - Warwasi level WWXX: Max length, width, and thickness for **prepared** cores.*

7.2.2 Unprepared cores

7.2.2.1 Cortex retention for unprepared cores

As could be expected, the unprepared cores show low figures for cortex retention (table 215).

7.2.3 Unprepared core technology and reduction

7.2.3.1 Overall core reduction method for unprepared cores

The overall core reduction method is firmly leaning towards *ad hoc* blank production, seen here as the migrating platform method (table 216). This is likely associated with the relatively small size of dimensions for the nodules described above, and could be evidence of raw material exhaustion.

	Frequency	Percent
0%	2	28.6
>0-25%	3	42.9
ca50%	2	28.6
Total	**7**	**100.0**

Table 215 - Warwasi level WWXX: Cortex retention on surface area of unprepared cores

	Frequency	Percent
SinglePlatformUnprepared	1	14.3
BipolarUnprepared	1	14.3
MigratingPlatform	4	57.1
Discoidal	1	14.3
Total	**7**	**100.0**

Table 216 - Warwasi level WWXX: Characterization of overall core reduction method in unprepared cores

7.2.4 Core episodes, flake removals, and reduction intensity for unprepared cores

Half of the cores preserve evidence for four core episodes with a mean of three (tables 217-218), and the total number of removals range between 7-15 with a mean of 10 (tables 219-220). This reflects the findings already argued above of high intensity exploitation of the raw material.

Total number of core episodes	Frequency	Percent
1	1	14.3
2	2	28.6
3	1	14.3
4	3	42.9
Total	**7**	**100.0**

Table 217 - Warwasi level WWXX: Total number of core episodes for all unprepared cores

	N	Min.	Max.	Mean
Total number of core episodes	7	1	4	2.86

Table 218 - Warwasi level WWXX: Min, Max, and Mean of core episodes for all unprepared cores

Total number of removals	Frequency	Percent
7	1	14.3
8	2	28.6
10	1	14.3
11	2	28.6
15	1	14.3
Total	**7**	**100.0**

Table 219 - Warwasi level WWXX: Total number of removals for all unprepared cores.

	N	Min.	Max.	Mean
Total number of removals	7	7	15	10.00

Table 220 - Warwasi level WWXX: Min, Max, and Mean of removals for all unprepared cores.

7.2.5 Core size compared to largest flake detachment

Mean size of largest flake scar is 36 mm in length and 18 mm in width (table 221).

	N	Min.	Max.	Mean
Size of largest scar length	7	15.00	78.08	36.5443
Size of largest scar width	7	11.00	28.83	18.3471

*Table 221 - Warwasi level WWXX: Size of largest flake scar **length** and **width** for all unprepared cores.*

7.2.5 Prepared core reduction and technology

7.2.5.1 Preparatory flake scars

Preparatory scar numbers on both striking platform surface and flaking surface are evenly distributed between 5 and 13, and 4 and 12, respectively, with a mean number of 8 for both (tables 222-225).

Number of preparatory scars on striking platform surface	Frequency	Percent
5	1	12.5
6	1	12.5
7	2	25.0
8	1	12.5
10	2	25.0
13	1	12.5
Total	**8**	**100.0**

Table 222 - Warwasi level WWXX: Number of preparatory scars on striking platform surfac

	N	Min.	Max.	Mean
Number of preparatory scars on striking platform surface	8	5	13	8.25

Table 223 - Warwasi level WWXX: Min, Max, and Mean of Number of Preparatory Scars on Striking Platform Surface

Number of preparatory scares on flaking surface	Frequency	Percent
4	2	25.0
6	1	12.5
8	1	12.5
9	1	12.5
10	2	25.0
12	1	12.5
Total	**8**	**100.0**

Table 224 - Warwasi level WWXX: Number of preparatory scars on flaking surface

	N	Min.	Max.	Mean
Number of preparatory scars on flaking surface	8	4	12	7.88

Table 225 - Warwasi level WWXX: Min, Max, and Mean of Number of Preparatory Scars on Flaking Surface

7.2.5.2 Numbers and Dimensions of Definite End Products

Half of the cores preserve evidence for just one **definite end product** having been detached, with two and even three recorded for the rest (tables 226-227). This gives a mean of 1.5 for the assemblage. This author will admit the difficulty in identifying the correct number of detached end products from a final flaking surface in some instances, as preparation scars can sometimes be mistaken for scars of end products.

Mean length and width for **final Levallois product** is 21 and 19 mm, respectively (tables 228-230).

No. of definite Levallois products	Frequency
1	4
2	2
3	1
Total	7

Table 226 - Warwasi level WWXX: Number of definite Levallois products detached from final flaking surface

	N	Min.	Max.	Mean
Number of definite Levallois products detached from final flaking surface	7	1	3	1.57

*Table 227 - Warwasi level WWXX: Min, Max, and **Mean** of Number of Definite Levallois Products Detached from Final Flaking Surface*

Dimensions of final product length (mm)	Frequency	Percent
12.84	1	12.5
13.17	1	12.5
15.36	1	12.5
16.00	1	12.5
21.77	1	12.5
26.80	1	12.5
27.72	1	12.5
35.86	1	12.5
Total	**8**	**100.0**

Table 228 - Warwasi level WWXX: Dimensions of final Levallois product length

Dimensions of final product length (mm)	Frequency	Percent
11.65	1	12.5
14.21	1	12.5
15.00	1	12.5
16.31	1	12.5
17.53	1	12.5
18.74	1	12.5
21.83	1	12.5
35.26	1	12.5
Total	8	100.0

Table 229 - Warwasi level WWXX: Dimensions of final Levallois product width

	N	Min.	Max.	Mean
Dimensions of Final Levallois Product Length	8	12.84	35.86	21.19
Dimensions of Final Levallois Product Width	8	11.65	35.26	18.81

Table 230 - Warwasi level WWXX: Min, Max, and ***Mean*** *of Dimensions of Final Levallois Product Length and width*

7.2.5.3 Methods of Preparation and Exploitation of Final Flaking Surface

Method of preparation of final flaking surface is mostly centripetal, when identifiable (table 231). The **method of exploitation** of the final flaking surface is most commonly lineal, with both unipolar and centripetal recurrent present (table 232). It is assumed that the centripetal method of preparation is being precipitated by the increasingly small volume of the core blanks. Table 233 displays method of preparation of final flaking surface by method of exploitation of final flaking surface.

Method of preparation	Frequency	Percent
Unipolar	1	12.5
ConvergentUnipolar	1	12.5
Centripetal	3	37.5
Indeterminate	3	37.5
Total	**8**	**100.0**

Table 231 - Warwasi level WWXX: Method of preparation of final flaking surface

Method of exploitation	Frequency	Percent
Lineal	4	50.0
UnipolarRecurrent	1	12.5
CentripetalRecurrent	1	12.5
FailedFinalRemoval	1	12.5
Re-preparedUnexploited	1	12.5
Total	**8**	**100.0**

Table 232 - Warwasi level WWXX: Method of exploitation of final flaking surface

		MethodOfExploitationOfFinalFlakingSurface1				
		Lineal	Unipolar Recurrent	Centripetal Recurrent	Failed Final Removal	Re-prepared Unexploited
		Count	Count	Count	Count	Count
Method of Preparation of Final Flaking Surface	Unipolar	1	0	0	0	0
	UnidirectionalLateral	0	0	0	0	0
	ConvergentUnipolar	0	1	0	0	0
	Bipolar	0	0	0	0	0
	BipolarLateral	0	0	0	0	0
	Centripetal	2	0	1	0	0
	Indeterminate	1	0	0	1	1

Table 233 - Warwasi level WWXX: Method of preparation of final flaking surface ***by*** *Method of exploitation of final flaking surface*

7.2.5.4 Earlier Flaking Surface and End Product Morphology from Final Flaking Surface

Five of the cores show evidence of an **earlier flaking surface** (table 234). Looking at the morphology of the **Levallois end product from the final flaking surface** of the eight cores, there are four flakes, three failed removals, and an unexploited surface (table 235). The failed removals are arguably a sign of the cores reaching the limit of their exploitability, at which point a serviceable end product can no longer be detached.

Evidence of earlier flaking surface		Frequency	Percent
	No	3	37.5
	Yes	5	62.5
	Total	**8**	**100.0**

Table 234 - Warwasi level WWXX: Evidence of earlier flaking surface

Morphology of Levallois products		Frequency	Percent
	Flake	4	50.0
	Failed	3	37.5
	Unexploited	1	12.5
	Total	**8**	**100.0**

Table 235 - Warwasi level WWXX: Morphology of Levallois products from final flaking surface

7.2.5.5 Cortex retention and distribution

In terms of cortex retention and distribution, the one half of the cores are either almost or fully decorticated, whereas the other half retains between more than 50% and more than 75% (tables 236-237). This is probably explainable through the relationship between cut-off size for serviceable end products and original size of core blanks. If the size of the remaining core blank is too small to permit a serviceable end product, arguably, there would have been no need to pursue further reduction. In such case, a discarded nodule could retain a substantial amount of cortex, concurrent with having been deemed exhausted (and ultimately discarded).

Extent of cortex on striking platform surface		Frequency	Percent
	0%	2	25.0
	>0-25%	1	12.5
	ca50%	1	12.5
	50-75%	2	25.0
	>75%	2	25.0
	Total	**8**	**100.0**

Table 236 - Warwasi level WWXX: Extent of cortex on striking platform surface

Portion of cortex on striking platform surface	Frequency	Percent
None	2	25.0
One Edge Only	1	12.5
Central	1	12.5
Central and One Edge	2	25.0
Central and More Than One Edge	2	25.0
Total	**8**	**100.0**

Table 237 - Warwasi level WWXX: Portion of cortex on striking platform surface

7.2.5.6 Remnant Distal Ends on Striking Platform Surface

Just over half of the cores preserve **evidence for remnant distal ends** on the striking platform surface, demonstrating the detachment of flakes at an earlier stage in the use-life of the core. Such an insight lets us speculate about the original size of the core blank prior to discard (table 238).

Remnant distal ends on striking platform surface		Frequency	Percent
	Yes	5	62.5
	No	3	37.5
	Total	8	100.0

Table 238 - Warwasi level WWXX: Remnant distal ends on striking platform surface

7.2.6 Flakes

7.2.6.1 Flake assemblage by techno-typology

The WWXX flake assemblage (table 239) is comprised of just under 60% unretouched flakes, 25% retouched flakes, 8% tools and 8% core-on-flakes (table 240). Looking only at whole flakes, unretouched flakes drops with 50%, retouched flakes are reduced by 2/3, tools are reduced by 50%, and core-on-flakes are, perhaps not surprisingly, almost entirely eliminated (table 241). For the core-on-flakes, the fact that they are not preserved on whole flakes does not eradicate their analytical potential, and they will be described below. As for the rest of the whole flake assemblage, enough material is available as to exclude the broken flakes from analysis, except for instances of usefulness, such as for comparing butt types and platform dimensions.

Spits	Frequency	Percent
PP	6	1.2
QQ	6	1.2
RR	7	1.4
SS	6	1.2
TT	4	.8
UU	19	3.8
VV	18	3.6
WW	216	42.8
XX	161	31.9
YY	5	1.0
ZZ	1	.2
AAA	30	5.9
BBB	18	3.6
CCC	8	1.6
Total	**505**	**100.0**

Table 239 - Warwasi flakes by 10 cm spits (level)

Data class	Frequency	Percent
CoreOnFlake	31	8.2
RetouchedFlake	95	25.2
UnretouchedFlake	219	58.1
Tool	31	8.2
Multi-Tool	1	.3
Total	**377**	**100.0**

Table 240 - Warwasi level WWXX: flakes by data class

Data class	Frequency	Percent
CoreOnFlake	2	1.2
RetouchedFlake	33	19.6
UnretouchedFlake	116	69.0
Tool	16	9.5
Multi-Tool	1	.6
Total	**168**	**100.0**

Table 241 - Warwasi level WWXX: WWXX flakes by data class

7.2.6.2 Complete flakes

Flake dimensions

The Warwasi flake population is not characterised by large flakes. The flakes are just over 30 mm in mean **length** and about 20 mm in mean **width**, with a mean **thickness** of 6 mm (tables 242-243). The low discrepancy between **length P** and **Length P Max** suggest relatively symmetrical flakes. As the mean core size is 41 mm and 37 mm for length and width, respectively, flake size corresponds to the cores in a way as to conclude the Warwasi flake assemblage could have been produced from the Warwasi core assemblage. **Platform width** is three times greater than **platform thickness**, being 12 mm and 4 mm, respectively (figures 69-70).

	N	Minimum	Maximum	Mean
MaxLength	164	10.67	75.82	32.8815
FlakeLengthP	164	11.35	66.81	30.3217

Table 242 - Warwasi level WWXX: Min, Max, and Mean of Length P and Length P Max

	N	Minimum	Maximum	Mean
MaxWidth	168	8.52	50.09	21.7324
MaxThickness	168	1.65	23.26	5.8972

Table 243 - *Warwasi level WWXX:* Min, Max, and **Mean** of Width and Thickness

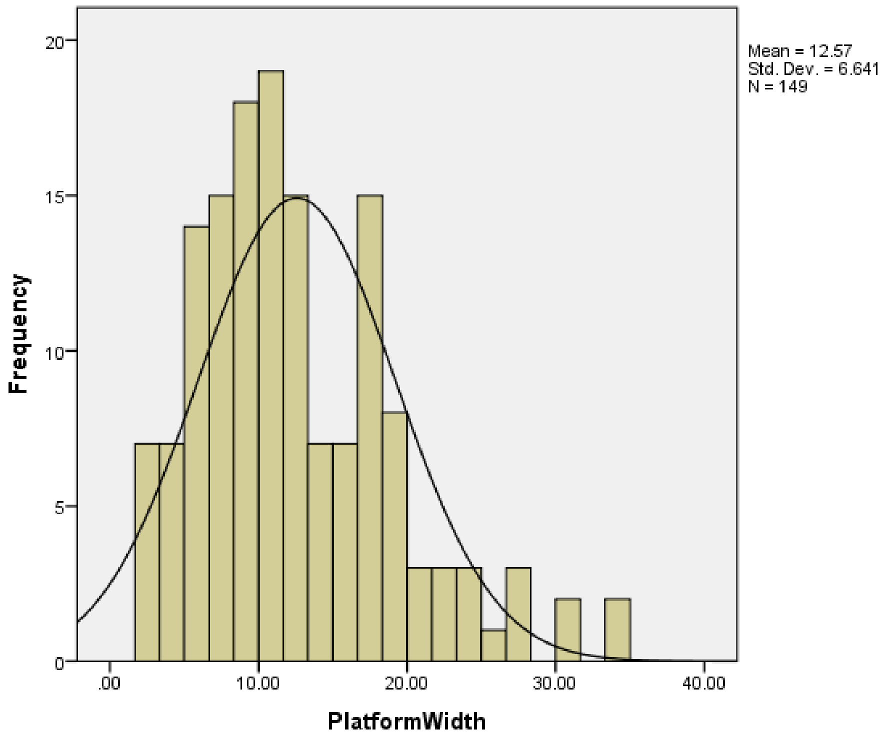

Figure 69 - Warwasi level WWXX: Platform width

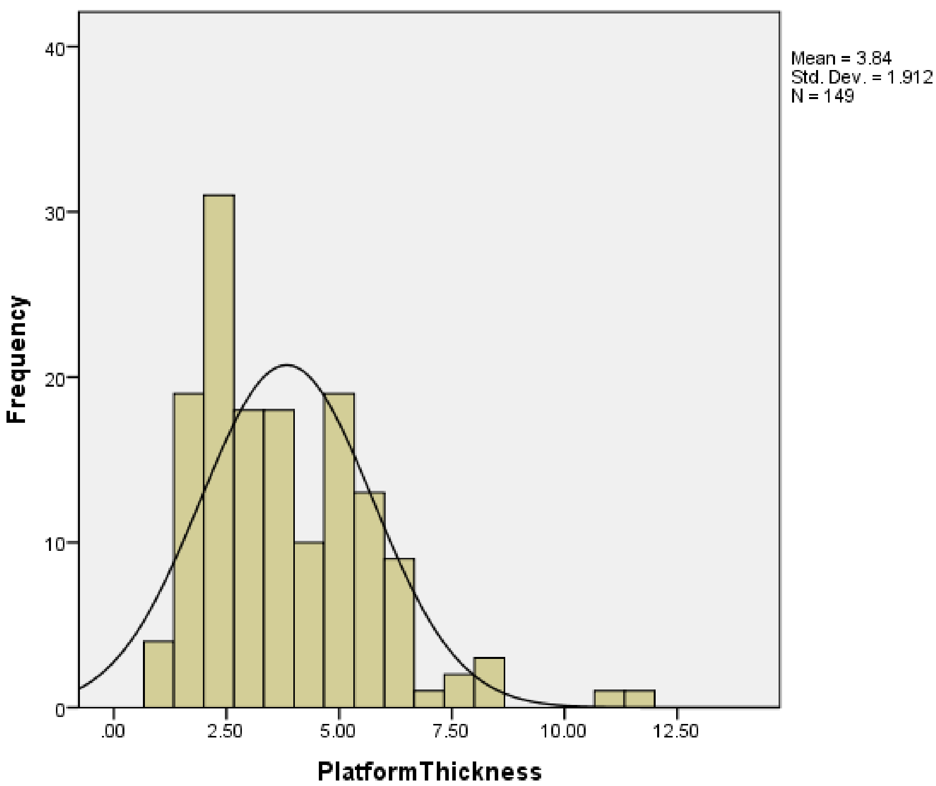

Figure 70 - Warwasi level WWXX: Platform thickness

7.2.7 Dorsal indices of flakes

7.2.7.1 Dorsal scar count

Dorsal scar count is relatively high with a mean of five per flake (tables 244-245). With only one fully cortical flake, three to seven dorsal scars are most common, with one flake exhibiting up to 13 scars.

Dorsal scar count	Frequency
0	1
1	3
2	9
3	23
4	30
5	30
6	23
7	17
8	10
9	5
10	5
13	1
Total	**157**

Table 244 - Warwasi level WWXX: Dorsal scar count

	N	Minimum	Maximum	Mean
DorsalScarCount	157	0	13	5.13

Table 245 - Warwasi level WWXX: Dorsal scar count

7.2.7.2 Dorsal scar pattern

The reason for developing the rigorous framework for recording **dorsal scar pattern** used in this thesis (see Chapter 4), was with the hope of reducing the category of "indeterminate" pieces. Unfortunately, even with handheld magnification, 1/3 of the dorsal scar patterns are considered indeterminate (Table 246). The indeterminate category differs from the obscured category (6%) by virtue of not being obscured by anthropogenic and/or natural processes, but simply having a dorsal scar pattern that is indeterminate to the analyst. This is usually due to a combination of factors like undistinguishable dorsal arrises and/or lack of ripple marks within a particular dorsal scar.

Case in point: 7% of the flakes show a proximal dorsal scar pattern, and 5% show a bidirectional pattern running proximal-distal. An indeterminate group of flakes of 15% are considered struck from either proximal *or* distal, or both proximal *and* distal. Either way, a maximum of one act of core rotation is attestable, involving either unidirectional or bidirectional flaking. By saving this particular group from the analytical obscurity of "indeterminate", at least some behavioural information can be extracted, and a more analytically substantial group of dorsal scar patterning can be mounted by pooling these three sub-groups together. This group would amount to 27%. Flaking exclusively from laterals, right or left, or both, are almost entirely absent.

Multi-directional flaking, which is classified as non-bidirectional flaking from two directions, i.e. also involving one act of core rotation, but limited to 90° as opposed to 180° for bi-directional, covers 16% of the flake population. Multi-directional flaking is distinguished from bidirectional flaking because it is seen to be less likely to be part of an interrelated flake detachment process, i.e. where bidirectional flaking can be an act of facilitating the preferred end products, non-bidirectional flaking is less likely to be interrelated, by the fact that the plains of the flakes detached intercepts at an angle, instead of being struck directly passed or to the distal end of the flake coming from the opposed direction.

Various types of radial flaking, involving from two to three, or more, core rotations, is seen in ca. 14%. Just short of 40% are either indeterminate or obscured. However, as mentioned previously, additional work needs to be done to improve the methodology, so as to better integrate “indeterminate” pieces exhibiting complex dorsal scar patterns.

This creates three main categories of dorsal scar patterns: Uni- or bidirectional (27%), multidirectional or radial dorsal scar patterns (30%), and indeterminate or obscured patterns (39%).

Dorsal scar pattern	Frequency	Percent
Proximal	12	7.1
Right	1	.6
Left	1	.6
IndeterminateUnidirRightLeftLateral	1	.6
IndeterminateUni-BidirProximalDistal	26	15.5
BidirectionalProximalDistal	8	4.8
Multi-directional	27	16.1
WeaklyRadial	12	7.1
StronglyRadial	4	2.4
Indeterminate(but radial)	7	4.2
ArrisedRadial	2	1.2
WhollyCortical	1	.6
Obscured	11	6.5
Indeterminate	54	32.1
Retouched	1	.6
Total	**168**	**100.0**

Table 246 - Warwasi level WWXX: Dorsal scar pattern

7.2.7.3 Dorsal cortex and cortex location

Looking at cortex retention, is seems to be very clear that the Warwasi assemblage is characterised by later stage (tertiary) reduction (Table 247). 86% of the flakes do not conserve cortex, with another 8% having less than 25%. This is more clearly illustrated in Table 248. Where cortex is present, with only one exception, it is located on the dorsal surface Table 249.

Dorsal cortex on flake	Frequency	Percent
0%	144	85.7
1-25%	14	8.3
26-50%	2	1.2
ca50%	6	3.6
76-99%	1	.6
100%	1	.6
Total	**168**	**100.0**

Table 247 - Warwasi level WWXX: Dorsal cortex on flake (no frequency for 51-75%)

Dorsal cortex on flake	Frequency	Percent
0-25%	157	94.0
25-75%	8	4.8
75-100%	2	1.2
Total	**167**	**100.0**

Table 248 - Dorsal cortex on flake grouped in 3 clusters

Flake cortex location	Frequency	Percent
DorsalOnly	23	13.7
PlatformOnly	1	.6
None	144	85.7
Total	**168**	**100.0**

Table 249 - Warwasi level WWXX: Flake cortex location

7.2.7.4 Redirection flakes

Redirection flakes, identifying pieces with part of a former core striking platform preserved on the dorsal surface or either edge, are conspicuously absent from the flake assemblage (Table 253). While this does not immediately correspond with the information obtained from the analysis of dorsal scar pattern above, where radial patterns were prominent, an explanation of their absence might be possible. If what we are seeing in unit WWXX at Warwasi truly represents later-stage knapping, arguably cores brought into the site might already have been reduced to their last "face" of reduction. By that is meant the core has been reduced to a level where only one cycle of further reduction can be achieved before discard is necessary. If this is the case, arguably, core-edge rejuvenation by redirection flakes (or core-trimming elements) likely would already have been performed elsewhere. An alternative explanation could be that these techno-typological pieces have been retouched into tools, thereby obscuring their original, debitage-stage, typology. Another possibility, although, admittedly, much less likely, is the removal of these particular pieces off-site for whatever reason.

7.2.7.5 Proximal indices of flakes

Butt type/platform

Facetting, interestingly, is the most common **platform preparation** among the Warwasi flakes (Table 250). With 40% of the flakes having facetted **butts**, this particular kind of preparation is almost twice as common as the standard, or default, plain butt (23%). This is interesting in a behavioural context, as facetted butts usually are argued to be associated with prepared core technology. The same is being argued for dihedral butts, although this type of preparation only is attested in around 5% of the flakes. Marginal butts, struck from a core edge forming a narrow, minimal butt, constitutes 7% of the assemblage. 20% are either obscured by damage or otherwise unidentifiable.

This picture is almost identical when whole flakes are combined with proximal (i.e. broken) flakes (table 251). The only discrepancies are with dihedral and retouched butts, doubling and tripling, respectively.

Butt types	Frequency	Percent
Plain	39	23.2
Dihedral	8	4.8
Cortical	1	.6
Natural(ButNonCortical)	1	.6
Marginal/Punctiform	12	7.1
Facetted	67	39.9
Obscured(e.g.bydamage)	35	20.8
Retouched	3	1.8
ChapeauDeGendarme	2	1.2
Total	168	100.0

Table 250 - Warwasi level WWXX: Butt types (whole flakes)

Butt types	Frequency	Percent
Plain	56	21.6
Dihedral	19	7.3
Cortical	1	.4
Natural (but non cortical)	1	.4
Marginal/ punctiform	19	7.3

Facetted	98	37.8
Missing	1	.4
Trimmed	1	.4
Obscured (e.g. by damage)	53	20.5
Retouched	8	3.1
Chapeau De Gendarme	2	.8
Total	**259**	**100.0**

Table 251 - Warwasi level WWXX: Butt types (whole and proximal)

7.2.7.6 Distal indices of flakes

Flake termination

Even with relatively small core blanks, **flake termination** traits traditionally attributed to reducing smaller volumes of raw material, such as hinge breaks and plunging (or overshot) pieces, are not overrepresented in the Warwasi flake assemblage. Together they account for 19% (Table 252). 16% have retouched terminations. Feather terminations, seen as a typological marker of controlled, successful detachment, is recorded for nearly 2/3 of the flakes.

Flake termination	Frequency	Percent
Feather	106	63.1
Hinge	20	11.9
Step(break/snap)	2	1.2
Plunging/Overshot	12	7.1
Retouched	28	16.7
Total	**168**	**100.0**

Table 252 - Warwasi level WWXX: Flake termination

Pointed flakes

Pointed flakes were recorded to see if a pattern could be observed (Table 254). Ca 8% were pointed by debitage, and a similar amount pointed by retouch.

Redirection flakes		Frequency	Percent
	Yes	5	3.0
	No	163	97.0
	Total	**168**	**100.0**

Table 253 - Warwasi level WWXX: Redirection flakes

Pointed flakes	Frequency	Percent
YesDebitage	13	7.7
YesRetouch	13	7.7
No	142	84.5
Total	**168**	**100.0**

Table 254 - Warwasi level WWXX: Pointed flakes

7.2.7.7 Typology

Following on from the previous chapters, the techno-typological appraisal of the flake assemblage will be based on the data class differentiation.

7.2.7.8 Retouched to Unretouched Flakes

The proportion of **retouched to unretouched flakes** is about ¼ (Table 255). If both whole and broken flakes are included, the proportion of retouched to unretouched changes to 1/3 (Table 256). Even when only considering whole flakes, 28% retouched flakes in an assemblage is quite a substantial amount.

	Frequency	Percent
Yes	47	28.0
No	121	72.0
Total	**168**	**100.0**

Table 255 - Warwasi level WWXX: Retouched flakes to non-retouched flakes (whole flakes)

	Frequency	Percent
Yes	125	33.2
No	252	66.8
Total	**377**	**100.0**

Table 256 - Warwasi level WWXX: Retouched flakes to non-retouched flakes (whole and broken flakes)

7.2.7.9 Retouched flakes to Tools

Dividing up the retouched assemblage by data class, ca. 2/3 are retouched flakes not attributable to Borders typology, while 1/3 can be categorised as formal tools (Table 257). If broken flakes are considered together with complete flakes, core-on-flakes rise from ca. 4% to 20%, which is to be expected, as their techno-typology entail the reduction of the flake-blank in question. Formal tools likewise form 20%, while non-typological retouched flakes stay almost the same at 60% (Table 258).

Data class		Frequency	Percent
	CoreOnFlake	2	3.8
	RetouchedFlake	33	63.5
	Tool	16	30.8
	Multi-Tool	1	1.9
	Total	**52**	**100.0**

Table 257 - Warwasi level WWXX: Retouched flakes to tools (whole flakes)

Data class		Frequency	Percent
	CoreOnFlake	31	19.6
	RetouchedFlake	95	60.1
	Tool	31	19.6
	Multi-Tool	1	.6
	Total	**158**	**100.0**

Table 258 - Warwasi level WWXX: Retouched flakes to tools (whole and broken flakes)

7.2.7.10 Tool Types

The distribution of tool types among whole flakes falls into two main parts: Burins and points (Table 259). Burins are ca. 10% and points ca. 20% of this assemblage of whole tools and retouched flakes, where non-formal retouched flakes make up the remaining 70%. The points can be divided in three groups: Levallois points, Mousterian points, and borers. Attributing specific functional significance to either tool type, as they relate to the WWXX context, would be beyond the scope of this study. Unretouched Levallois points, traditionally, are associated with hunting as spear armature (e.g. Shea 1989, 1995; Sisk and Shea 2009), but a functional difference between retouched Mousterian points and borers is debatable. All could arguably be coveted for their pointed end, while the lateral retouch on Mousterian points have been noted to have similar properties to double-, convergent- and déjeté scrapers (Lindly 1997; Dibble 1987).

When the whole assemblage including broken flakes are considered, most tool type distributions are reduced by between 50%-66%. Burins, however, stay the same at around 10% (Table 260).

Tool type	Frequency
Burin	5
Burin and Point	1
Levallois Point	3
Mousterian Point	3
Borer/ Bec/ Priser	5
Total	**17**

Table 259 - Warwasi level WWXX: Tool type (whole flakes)

Tool type	Frequency
Double Scraper	1
Burin	15
Burin and Point	1
Levallois Point	3
Mousterian Point	4
Borer/ Bec/ Priser	8
Total	**32**

Table 260 - Warwasi level WWXX: Tool type (whole and broken flakes)

7.2.7.11 Retouched Area Length vs. Length of Inverse Circumference of Flake

Looking at **length of combined retouch areas** to **length of inverse circumference** on all whole retouched flakes, almost half (45%) of a flake is retouched on average (tables 261-262). Numbers of retouched areas ranges from one to three, with one being most frequent with 50%, and two and three recorded at 27% and 13%, respectively. These figures roughly stay the same when only whole non-tool retouched flakes are examined (tables 263-264).

	N	Minimum	Maximum	Mean
LengthOfMargins	49	53.04	188.66	99.7924
RALength	49	4.33	108.47	45.4153

Table 261 - Warwasi level WWXX: Length of combined retouch areas ***to*** *length of inverse circumference on all retouched artefacts, whole: including core-on-flake, retouched flakes, tools, and multi-tools.*

No. of retouched areas	Frequency
1	26
2	14
3	7
Total	**47**

Table 262 - Warwasi level WWXX: Number of retouched areas on all retouched artefacts, whole: including core-on-flake, retouched flakes, tools, and multi-tools.

	N	Minimum	Maximum	Mean
LengthOfMargins	33	53.04	181.04	99.1106
RALength	33	5.82	108.47	44.8973

Table 263 - Length of combined retouch areas ***to*** *length of inverse circumference on retouched flakes (Retouched flakes only, whole)*

Number of retouched areas	Frequency	Percent
1	18	54.5
2	10	30.3
3	5	15.2
Total	**33**	**100.0**

Table 264 - Warwasi level WWXX: Number of retouched areas (Retouched flakes only, whole)

7.2.7.12 Truncated-Facetted Pieces

Truncated-facetted pieces are mentioned as a hallmark of some Zagros Mousterian assemblages (Shea 2013, Dibble and Holdaway 1993), and feature prominently in Lindly's (1997) techno-behavioural model. Within my WWXX unit, I have identified 13 (3.4%) (Table 265). All but one of these are recorded on broken flakes, which, like for the core-on-flakes, should not be assigned any behaviour-functional significance, as, by truncating and facetting a piece, it is by definition (usually at least) considered "broken", unless it clearly retains a proximal and a distal.

31 core-on-flakes were recorded among the whole and broken flakes (Table 266). Besides two, all were identified on broken pieces. The utilisation of core-on-flakes/Truncated-facetted pieces in the Zagros is assumed to be a strategy of raw material conservation, especially at higher elevations (Lindly 1997: 312-316).

Truncated-facetted		Frequency	Percent
	Yes	13	3.4
	No	364	96.6
	Total	**377**	**100.0**

Table 265 - Warwasi level WWXX: Truncated-facetted pieces (whole and broken)

N	31

Table 266 - Warwasi level WWXX: Core-on-flakes (whole and broken)

7.2.7.13 Retouch technique

In tables 267-270, the various forms of retouch recorded for a flake are presented. Flakes have been recorded as having from one to four separate (unconnected) areas of retouch. The position can be anywhere along the margin of a flake. The cut-off of four areas is arbitrary. This retouch can take many forms, turning a flake into either a formal (retouched) tool, or an informally retouched piece. As it is usually impossible to distinguish what area of retouch came before another in a sequence, the tables below should be seen only as an overview. Where direct, inverse, bifacial, and alternating retouch are technological terms adopted to specify types of retouch "mechanics" used to modify the edge of a flake in order to make a tool such as a scraper or point, other terms are more techno-typological in nature. Burination, and core-on-flake/truncated-facetting are more easily compartmentalised, facilitating typological distinction. Accordingly, I have divided core-on-flakes up into three types: flake detachment from the ventral side, from the dorsal side, and from both ventral and dorsal (table 271). I have defined 15 possible constellations of truncated-facetted pieces. Not all of them are found in the Warwasi assemblage (Table 272).

Retouch technique		Frequency	Percent
	Direct	99	26.3
	Inverse	6	1.6
	Bifacial	4	1.1
	Alternating	2	.5
	Burination	13	3.4
	CoreOnFlakeVen	6	1.6
	CoreOnFlakeDors	4	1.1
	CoreOnFlakeBoth	13	3.4
	TFpProx	1	.3
	TFpProxDist	1	.3
	TFpPRLlat	2	.5
	TFpPDRLlat	4	1.1
	N/A	222	58.9
	Total	**377**	**100.0**

Table 267 - Warwasi level WWXX: Retouch technique for retouch area 1

Retouch technique		Frequency	Percent
	Direct	46	12.2
	Inverse	6	1.6
	Bifacial	1	.3
	Alternating	1	.3
	Burination	10	2.7
	N/A	313	83.0
	Total	**377**	**100.0**

Table 268 - Warwasi level WWXX: Retouch technique for retouch area 2

Retouch technique		Frequency	Percent
	Direct	8	2.1
	Inverse	4	1.1
	Bifacial	1	.3
	Burination	6	1.6
	N/A	358	95.0
	Total	**377**	**100.0**

Table 269 - Warwasi level WWXX: Retouch technique for retouch area 3

Retouch technique		Frequency	Percent
	Direct	2	.5
	Burination	1	.3
	N/A	374	99.2
	Total	**377**	**100.0**

Table 270 - Warwasi level WWXX: Retouch technique for retouch area 4

Retouch technique		Frequency	Percent
	CoreOnFlakeVen	6	19.4
	CoreOnFlakeDors	4	12.9
	CoreOnFlakeBoth	13	41.9
	TFpProx	1	3.2
	TFpProxDist	1	3.2
	TFpPRLlat	2	6.5
	TFpPDRLlat	4	12.9
	Total	**31**	**100.0**

Table 271 - Warwasi level WWXX: Core-on-flake by retouch technique

TFpProx	Truncated-facetted piece, proximal
TFpDist	Truncated-facetted piece, distal
TFpProxDist	Truncated-facetted piece, proximal and distal
TFpRightlat	Truncated-facetted piece, right lateral
TFpLeftlat	Truncated-facetted piece, left lateral
TFpRightLeftlat	Truncated-facetted piece, right and left lateral
TFpPRlat	Truncated-facetted piece, proximal and right lateral
TFpPLlat	Truncated-facetted piece, proximal and left lateral
TFpPRLlat	Truncated-facetted piece, proximal, right and left lateral
TFpDRlat	Truncated-facetted piece, distal and right lateral
TFpDLlat	Truncated-facetted piece, distal and left lateral
TFpDRLlat	Truncated-facetted piece, distal, right and left lateral
TFpPDRlat	Truncated-facetted piece, proximal, distal and right lateral
TFpPDLlat	Truncated-facetted piece, proximal, distal and left lateral
TFpPDRLlat	Truncated-facetted piece, proximal, distal, right and left lateral

Table 272 - Truncated-facetted pieces by retouch technique

7.2.8 Levallois

7.2.8.1 Levallois by whole/broken flakes

There is a very strong Levallois segment within the Warwasi WWXX flake assemblage. 17.5% among all flakes (whole and broken) and a massive 27% among whole (tables 273-274). There is an almost 50/50 split between modified and unmodified pieces in the full Levallois assemblage including broken pieces (Table 275), a figure which is only slightly decreased when only whole flakes are considered (Table 276).

	Frequency	Percent
Yes	66	17.5
No	311	82.5
Total	**377**	**100.0**

Table 273 - Warwasi level WWXX: Percentage of Levallois within flake assemblage (whole and broken)

	Frequency	Percent
Yes	45	26.8
No	123	73.2
Total	**168**	**100.0**

Table 274 - Warwasi level WWXX: Percentage of Levallois within flake assemblage (whole)

Data class	Frequency	Percent
CoreOnFlake	1	1.5
RetouchedFlake	20	30.3
UnretouchedFlake	34	51.5
Tool	11	16.7
Total	**66**	**100.0**

Table 275 - Warwasi level WWXX: Levallois by data class (whole and broken)

Data class		Frequency	Percent
	RetouchedFlake	11	24.4
	UnretouchedFlake	25	55.6
	Tool	9	20.0
	Total	**45**	**100.0**

Table 276 - Warwasi level WWXX: Levallois by data class (whole)

7.2.8.2 Type of Levallois product in morphological terms

From a morphological study of the whole pieces, Levallois flakes by far constitute the majority of the **typological specimens** with more than 70% (Table 277). Some of these flakes are arguably either not necessarily desired (debordant and overshot flakes), or possibly not detached as "preferred end products" at all, but rather constitutes flakes removed as part of maintaining the cores distal and lateral convexities. Levallois blades and Levallois points make up just 20% combined.

Levallois product		Frequency	Percent
	Flake	26	57.8
	Blade	6	13.3
	Point	3	6.7
	DebordantFlake	3	6.7
	DebordantAndOvershot	3	6.7
	indeterminate	4	8.9
	Total	**45**	**100.0**

Table 277 - Warwasi level WWXX: Type of Levallois product in morphological terms

7.2.8.3 Number of preceding Levallois removals

Ca. 50% of the flakes preserve evidence for a **preceding Levallois removal**, while two and even three previous removals are recorded. Around 20% show no previous removals (Table 278).

# of preceding Levallois removals	Frequency	Percent
0	8	17.8
1	22	48.9
2	3	6.7
3	3	6.7
Total	**36**	**80.0**

Table 278 - Number of preceding Levallois removals

7.2.8.4 Mode of preparation

Unfortunately, **mode of preparation** was indeterminate in half of the flakes analysed (Table 279). Where identifiable, centripetal preparation was most common with ca. 30%. This would seem to fit with the information regarding the relatively small size of the prepared cores. Centripetal preparation is often assumed to have been utilised for the final mode of reduction, as a core blank was becoming too small for alternative preparatory strategies to be employed.

Mode of preparation	Frequency	Percent
ConvergentUnipolar	2	4.4
Bipolar	7	15.6
Centripetal	13	28.9
Indeterminate	23	51.1
Total	**45**	**100.0**

Table 279 - Mode of preparation

7.2.8.5 Mode of exploitation

Mode of exploitation is more differentiated, although more than 70% of flakes are taken off from proximal, either through lineal, single removal, or unipolar recurrent exploitation (Table 280). Bipolar recurrent and centripetal recurrent is present, with just under 20% being indeterminate. Only about 15% of the Levallois flakes exhibit signs of having been re-prepared (Table 281).

Mode of exploitation		Frequency	Percent
	Lineal	15	33.3
	SingleRemoval	1	2.2
	UnipolarRecurrent	16	35.6
	BipolarRecurrent	2	4.4
	CentripetalRecurrent	3	6.7
	Indeterminate	8	17.8
	Total	**45**	**100.0**

Table 280 - Mode of exploitation

Evidence of repreparation		Frequency	Percent
	Yes	7	15.6
	No	38	84.4
	Total	45	100.0

Table 281 - Evidence of repreparation

7.2.8.5 Discussion of the Warwasi Unit WWXX assemblage

I chose to create an arbitrary unit from my sample of levels WW and XX as they are both by far the most lithic-rich of the original assemblage, and also my largest sample units. It is my assumption that by using only material from two levels, which corresponds to ca. 20 cm horizontally, I decrease the risk of mixing unrelated assemblages, and retain an acceptable degree of chronostratigraphy, if only a proxy.

7.2.8.6 Raw material sourcing

Raw material sourcing was not pursued. It is the assumption of this study that raw material in the shape of cores and flakes were brought into the rockshelter from sources in the landscape. This raw material is mainly chert/flint of multiple colours similar to sites like Shanidar and Houmian.

7.2.9 Core to flake correlation and on-site core reduction

Only 15 cores were available in my Unit WWXX, and were divided with one half being prepared cores, and one half being unprepared. The unprepared cores have mean dimensions of 44 mm, 36 mm, and 24 mm for length, width, and thickness, respectively. The prepared cores have mean dimensions of 39 mm, 38 mm, and 18 mm for length, width, and thickness, respectively. It was found that the size of the prepared cores was more regular, or standardised, than the unprepared cores. This is assumed to be a result of deliberate technological choices and therefore behaviourally significant. All cores are made on nodules where identifiable, and it is assumed these are river pebbles or cobbles, either picked up at a water source, or obtained from terraces.

The unprepared cores are mainly exploited in an *ad hoc* fashion through migrating platforms, leaving little or no cortex. Multiple core episodes of flake detachment are identified, with an average of 10 flakes taken off per core. The average size of the largest extant flake scar on the discarded cores are 36 mm and 18 mm for length and width, respectively.

Flakes in the assemblage are 30 mm in length and 20 mm in width on average. With average core size being 41 mm and 37 mm, and mean size of largest flake scar being 36 mm and 18 mm, for length and width, respectively, the Unit WWXX flakes could have been produced from the Unit WWXX cores.

From flake dorsal scar patterns, we learn that the Unit WWXX flakes are the result of substantial core reduction. A high number of flakes have facetted butts which likely is associable with prepared core reduction.

Only about a third of the prepared cores (N=4) can be said to be "centripetal", i.e. be centripetally prepared before exploitation. Of these, only one core is both centripetally prepared and shows centripetally recurrent exploitation. While the core sample from Unit WWXX is quite small, the suggestion is not – at least within this discrete 20 cm horizontal spit – of an explicit reliance on "centripetal flaking", declared to be a hallmark of the vertical mobility strategy of the Zagros Mousterian (Lindly 1997). Looking at my entire prepared core assemblage from levels PP-CCC, however, centripetal cores do constitute the overwhelming majority of the identifiable core preparation categories (47%). This would serve to agree with Lindly's model.

7.2.10 Retouch intensity and tool types

The flakes from Unit WWXX divides up into ca. 60% unretouched flakes and ca. 40% retouched flakes and tools. For whole flakes that number is 72%-28%, respectively.
28% of the whole flakes are retouched, which is a lot of retouched pieces in an assemblage. This is even without taking into account the potential number of unretouched flakes used as tools without having been retouched, a part of the assemblage it would require micro-wear analysis to identify. The high number of retouched flakes could be a function of curation.

The formal tool types found in this assemblage is mostly burins and points and together they constitute ca. 30%. The points are Levallois, Mousterian, and borers.

The effort of recording amount of retouch on every retouched flake has made it possible to quantify this edge modification. The result suggests that, on average, ca. 45% of the edge of a retouched flake has been modified.

31 core-on-flakes, of which 13 can be classified as truncated-facetted pieces, were identified within Unit WWXX. This constitutes ca. 8% of Unit WWXX total and would seem to confirm

Lindly's model, emphasising the use of flakes employed as cores as a significant techno-behavioural trait of the vertical mobility strategy of the Zagros Mousterian (Lindly 1997).

7.2.11 Evidence for Levallois technology and reduction within Warwasi Unit WWXX

27% of the whole flakes in unit WWXX are Levallois. Of these, almost 50% are retouched flakes or tools. This amount is substantial and echoes the conclusion of modern studies of "Zagros Mousterian" sites (Dibble 1984a, b; Dibble and Holdaway 1993; and Lindly 1997), in acknowledging a significant Levallois presence

Levallois flakes are most prominent in the assemblage, with lower numbers of Levallois points and blades.

The average dimension of the last Levallois end product to be detached from a prepared core is 21 mm by 19 mm for length and width, respectively. The majority of the cores have had just one end product detached within the final phase of preparation.

Centripetal preparation is most common while method of final exploitation is usually lineal. A behavioural explanation for a predominantly centripetal mode of preparation is presumed to relate to the contention that centripetal knapping is the preferred option when raw material volume is low. There are other signs the cores analysed were considered fully exhausted by time of discard, as some of them exhibit either unsuccessful detachments or signs of aborted reduction.

Typological (Levallois) flakes are the most common end product from the cores discarded at the site, but other cores could potentially have been brought off-site, e.g. cores producing points, and discarded somewhere in the landscape.

7.2.12 Major insights to hominin behaviour at Warwasi based on data analysis

According to Lindly's (1997) model, centripetal flaking as mode of core reduction is supposed to transition or give way to a mode of core reduction based on using flakes as core blanks, in the shape of core-on-flakes and/or truncated-facetted pieces. In evidence from the overall sample assemblage (levels PP-CCC) both centripetal cores and flake blanks used as cores (core-on-flakes and truncated-facetted pieces) are widespread. Whether this would suggest some sort of "equidistance" in terms of hominin mobility, within this area of the Zagros Mountains, i.e. distance in elevation from low to high in the mountains, is unknown.

It is curious, however, that within Unit WWXX, centripetal flaking is sporadic while reduction of core-on-flakes and truncated-facetted pieces are significant. This could serve to question the consistency or regularity of the expectations proposed by Lindly (1997).

Overall, however, the testimony of the data presented in this data chapter, in general, serves to support the idea of techno-typological homogeneity between Warwasi Unit WWXX and that of Shanidar Unit S2, as representatives of the so-called Zagros Mousterian.

7.3 Summary of discussion of Warwasi Unit WWXX data analysis

Raw material sourcing

- Raw material sourcing was not pursued.
    - Assumption: raw material was brought into the rockshelter from sources in the landscape.

- **Core to flake correlation and on-site core reduction**
    - Core reduction could have taken place within Warwasi Unit WWXX.
        - Correlation of core and flake sizes.

Retouch intensity and tool types

- Ca. 60% unretouched flakes.
- Ca. 40% retouched flakes and tools.
    - 28% of whole flakes are retouched.
- Burins and points constitute ca. 30%.
    - The points are Levallois, Mousterian, and borers.
- Ca. 45% of the edge of a retouched flake has been modified.
- Core-on-flakes and truncated-facetted pieces comprise ca. 8%

Evidence for Levallois technology and reduction at Warwasi

- 27% of the whole flakes in unit WWXX are Levallois.
    - Ca. 50% are retouched flakes or tools.
    - Levallois flakes most prominent.
- Levallois cores seems to have been exhausted before discard

Major insights to hominin behaviour at Warwasi based on data analysis

- Centripetal flaking as mode of core reduction is rare within Unit WWXX.
    - Centripetal flaking does seem to be prevalent throughout the entire sample assemblage as a whole however.
- Core-on-flakes and truncated-facetted pieces are prevalent within Unit WWXX.
    - This is in accord with Lindly's Model

Chapter 8. Ksar Akil Data Analysis

8.1 Excavation

Ksar Akil is located on the Levantine coast (Figure 71). The area of the rock shelter selected for excavation was concentrated around the treasure-hunters pit, which was sitting against the back wall of the shelter, and this came to serve as a yardstick for the stratigraphy (Williams and Bergman 2010:119) (Figure 72). The grid was divided into 2 x 2 m squares on a north-south grid, $68m^2$ in total, and designated from "D" to "G", "3" to "7" (Figure 73). It is of some importance that these specific letter-and-number designations not be mistaken for, or equated with, the specific letter-and-number designations of the later excavations by Tixier (Tixier and Inizan 1981:355), as the latter's use of a "H" to "P"-grid does not correspond to the Boston College-Fordham University grid. According to Williams and Bergman (2010:120), the treasure hunters pit intrudes into part of squares F3 and E4, with a former incline into the pit cutting through what became squares E4, D5 and E5, D6 and E6, D7 and E7. The ca. 23 m sounding can be seen in Figure 74.

Excavation of deposits was done by local workmen, by method of shovel skimming, using hand-pics to break up the soil, then using trowels, and collecting the soil in baskets which were brought to sieves, described as being "of medium mesh" (Murphy 1938; Williams and Bergman 2010). Unfortunately, the exact mesh-size of the sieves are unknown, which means it is at present impossible to know what size of debitage (or micro-debitage) represented the cut-off. Finds were collected in bags designated with level, square, and date (Murphy 1938). Murphy states:

> "*Once the flint specimens were cleaned they were brought to a long work table where they were spread out for examination, selection, and classification … the general division was as follows: blades, knife blades, blades thinned at bulbar end and opposed by a point or a mass* [sic], *small blades with fine lateral retouch, scrapers according to their sub-divisions …, flakes, points, burins … cores, special, and various. The number of each type of tool was then*

counted and entered into a record book, as well as the number of rejections. The latter factor will always prove of greatest interest when the statistical record is completed and a proportion of unworked to worked pieces will be obtained … each individual tool was marked according to level and square and placed in uniform boxes likewise labelled with the same provenance … (Murphy 1938:274).

Bergman and Copeland (1986:iv) suggests that "*rejections seem to mean non-tools here, i.e. artefacts regarded as debitage*". This author does not agree with Bergman and Copeland that this is necessarily what Murphy meant, as it is not exactly clear whether Murphy would necessarily (always) equate e.g. an unretouched flake with a "non-tool" i.e. debitage.

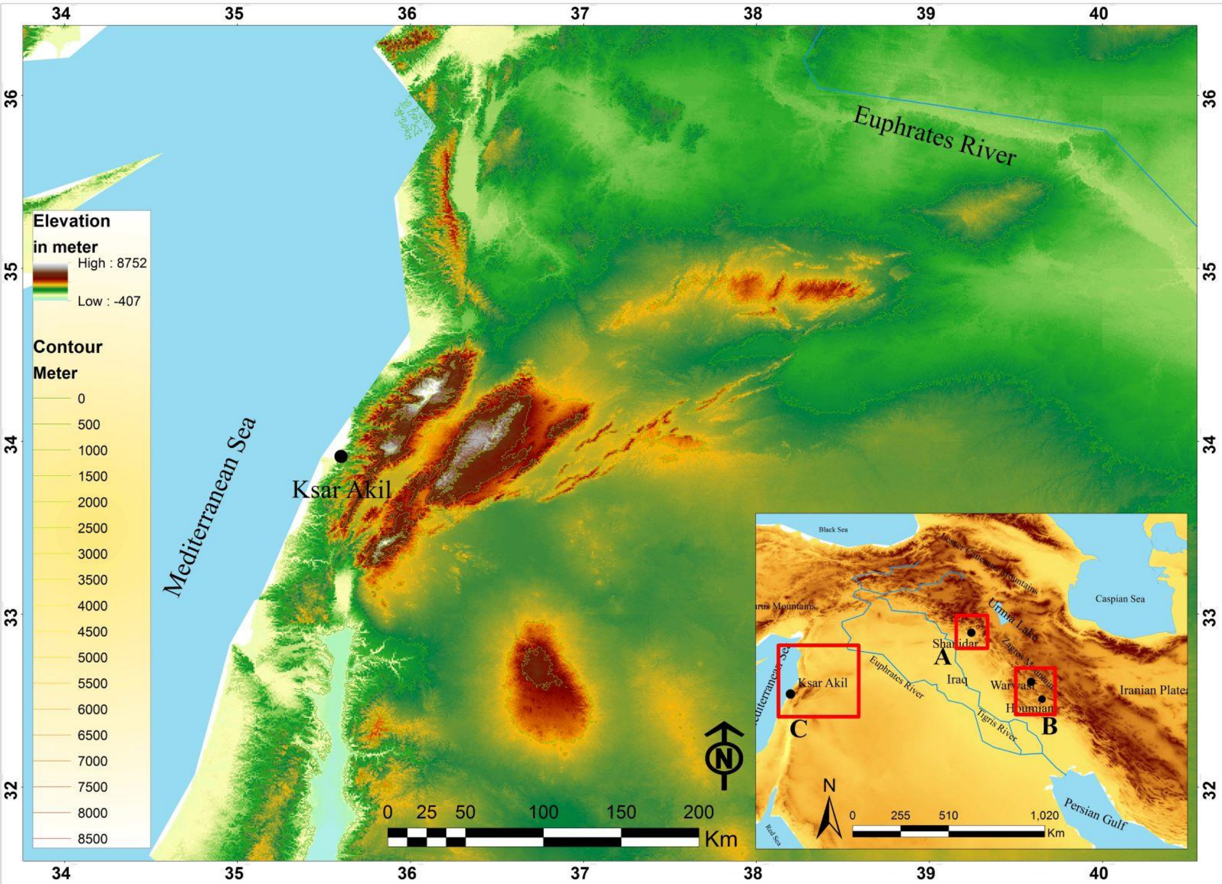

Figure 71 - Topographic map of the Levantine coast location of Ksar Akil.

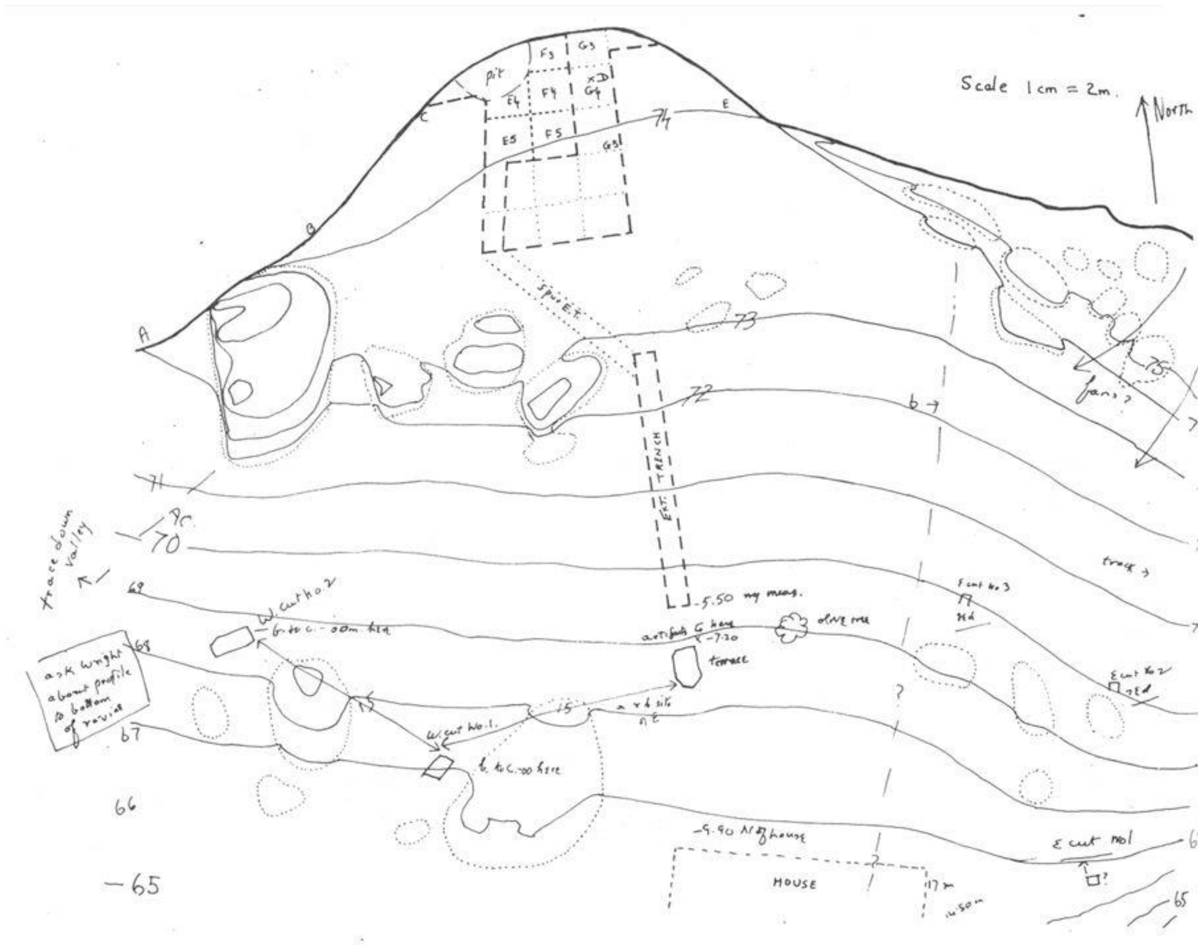

Figure 72 - Hand-drawn plan of Ksar Akil by Ewing. Dotted lines are rock falls and large boulders. Thick line outlines the shelter wall. Thin lines denote altitude above sea level. "Cuts" represent small soundings for soil and pollen samples. The dashed lines show extent of excavation. From Bergman and Copeland in Azoury (1986:IX).

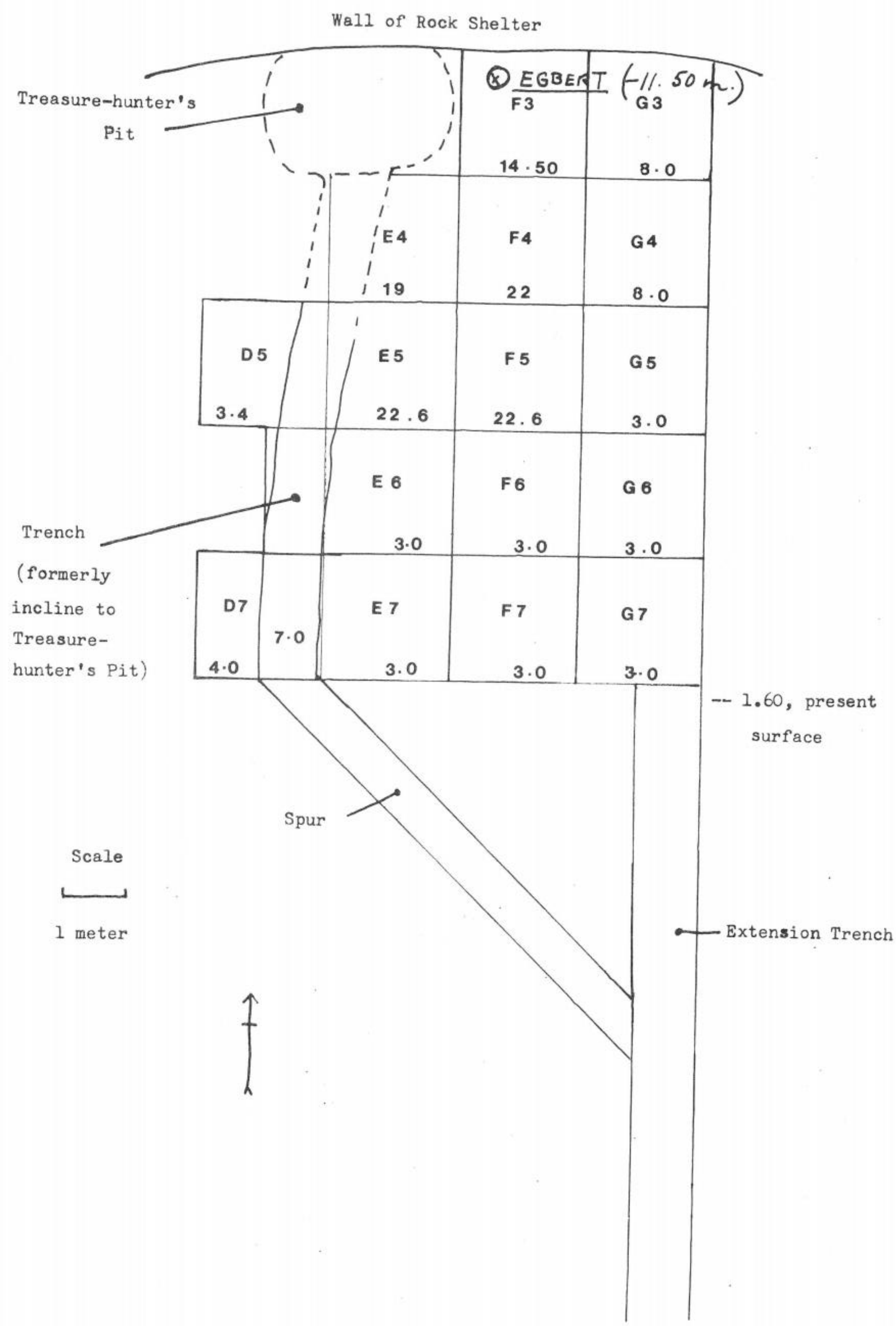

Figure 73 - Excavation grid showing the depth below datum reached. Position and depth of the hominin remains of "Egbert" is noted in Square F3. From Bergman and Copeland in Azoury (1986:X).

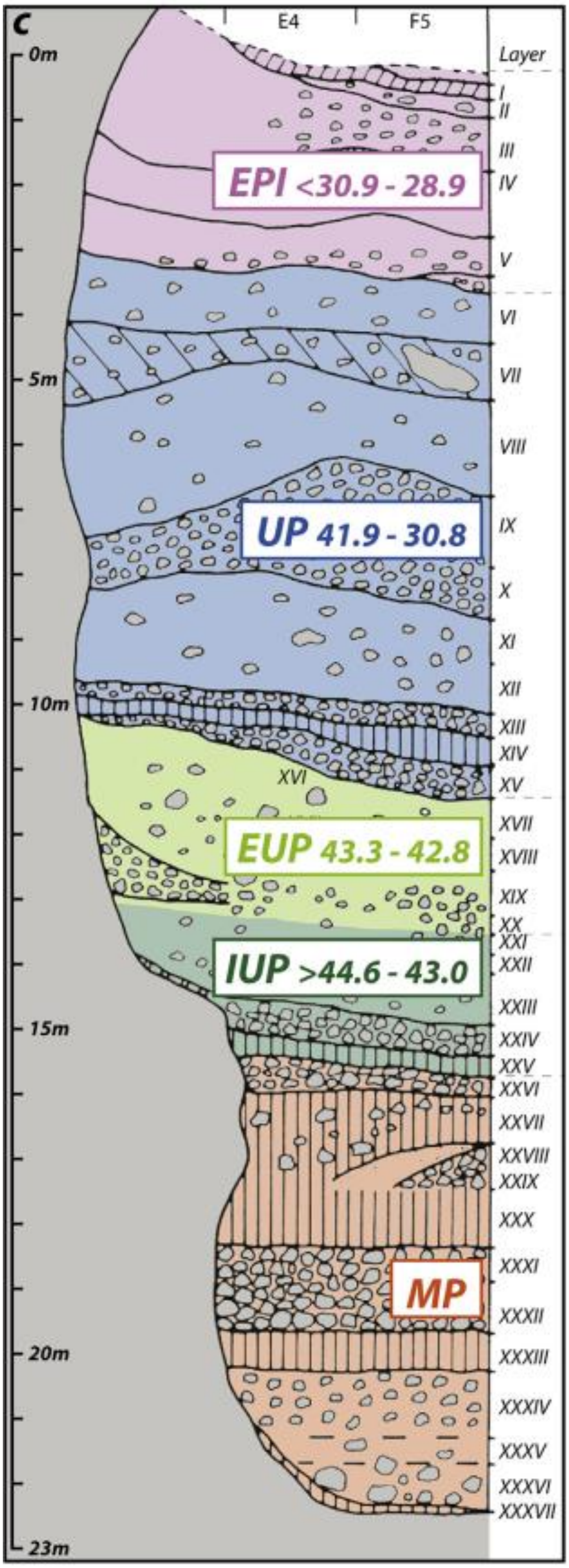

Figure 74 - Ksar Akil stratigraphy by Bosch et al. 2015b:86, with age-ranges after Bosch et al. (2015a), based on Ohnuma and Bergman (1990). Sequence from bottom to top: Middle Palaeolithic (MP), Initial Upper Palaeolithic (IUP), Early Upper Palaeolithic (EUP), Upper Palaeolithic (UP), and Epipalaeolithic (EPI).

8.2 Curational history

Murphy (1938, 1939) would later publish two short papers on excavation methodology at Ksar Akil. Based on these papers, Bergman and Copeland calls Murphy a "*'new archaeologist' before his time*" (1986:iii). Bergman (1987: 4), however, suggest that "[i]*t would appear that artefact collection was limited in many cases to recognisable tool forms. The general absence of 'chips', burin spalls and small tools (Tixier and Inizan 1981; Azoury 1986) is probably related in part to the mesh size of the sieves used*", and subsequently cite that "*Murphy (1938:237) reports that a 'medium grade' sieve was used on all the sediments*" (Bergman 1987: 4). Bergman goes on to suggest that "[t]*he fact that most of the digging was carried out by local untrained Lebanese, even though under supervision, probably also contributed to poor recovery* (Bergman 1987: 4). This, unfortunately, perpetuates an impression that these classes of artefacts were not recovered <u>in excavation</u> through a combination of sub-par equipment (mesh size) and unfocused workmen. This is in direct opposition to Ewing's (1947: 190) published information, written before the commencement of the 1947-1948 campaign, stating specifically "[t]*he flints already removed number close on 2,000,000 counting* ***both artefacts and rejected fragments, trimming flakes, etc***" [emphasis mine]. Ewing continues: "*Insofar as these have been studied, the rejects as well as the retained specimens have been counted and recorded by square and level*" (Ewing 1947:190). Concerning the workmen, Ewing is full of praise: "*During the process of excavation, the diggers placed the flints and bones they noted into marked bags; the rest of the material from the layer was sent to the sieves. Both diggers and sieve-men became very skilful at descrying* ***even the smallest specimen****. This was particularly striking when the clayey layers were reached, since in this difficult deposit the sieve-men would pick out tiny bones of microfauna with amazing verve*" (Ewing 1947:190. Emphasis mine). It is important to note Ewing writes this *before* the start of the 1947-1948 campaign, i.e. his comments pertain to the 1937-1938 campaign, thus before the onset of the second campaign wherein Williams and Bergman (2010) notes a shift in the on-site curation strategy.

Williams and Bergman (2010: 119) do concede that excavations generally were good for their times and flag what they perceive as an increase in standards in the 1947-1948 campaign compared to the previous of 1937-1938. This, they express, manifested in that "*the stratigraphic designations were changed to reflect finer subdivisions within individual levels*" and that "*it appears that greater attention was paid to collecting smaller artefacts like bladelets*" (Williams and Bergman 2010: 118).

The material is sent to the Harvard Peabody Museum and placed in the care of John Otis Brew and later Hallam L. Movius. Bergman and Copeland (1986: vi) relates how John Waechter, then of the Institute of Archaeology in London, is permitted to study part of the collections in 1965, under the auspices of Ewing and Movius. While the exact circumstances are unclear (Bergman and Copeland 1986: vi), Waechter divides up the Ksar Akil lithic assemblages and moves a large part of it to the UK. Waechter seems to have intended to focus on the Middle Palaeolithic assemblages, leaving the Upper Palaeolithic assemblages to publication by successive generations of UCL students. By the time of his untimely death in 1978, only an unpublished conference paper is realised of this work on the Middle Palaeolithic material, and nothing is known of the Middle Palaeolithic layers until Copeland (1975) presents her organisation of the Levantine Mousterian, wherein she incorporates Waechter's London part of the Ksar Akil Middle Palaeolithic. The full, surviving, part of layers XXVI-XXXVI, including both the US and UK collections, are not published until Marks and Volkman's study in 1986.

The Ksar Akil lithic assemblages are still today split between various institutions worldwide, with the main parts housed in the Harvard Peabody Museum of Archaeology and Ethnology, The British Museum, and likely various museums in Beirut, Lebanon. With the focus of this study being on the Middle Palaeolithic assemblages, the main collections of these are curated by the Harvard Peabody Museum, with a known smaller sample kept at the "Frank's House" repository of the British Museum. The precise number of curated material pertaining to the Middle Palaeolithic is unknown to this author, but it is assumed the 4661 pieces studied by Marks and Volkman (1986) reflects what can be considered close to the total surviving amount. Because the Ksar Akil material is argued to represent two chronological periods within the Middle Palaeolithic (See Chapter 2), and because of its low elevation relative to the Zagros assemblages, it was considered a suitable reference collection. As such its resolution and associated proxy data makes is similar to those of the Zagros Mountains.

8.2.1 Sampling method and Assemblage composition of the lithics

I sampled 267 lithics from the Ksar Akil assemblage in the Harvard Peabody Museum collection. I chose to sample layers XXVIA (26A), XXVIIA (27A), and XXVIIIA (28A) from square E5, as the faunal material from these layers should see publication in the near future and could shed light on the lithic technological behaviour. I analysed the available material from Square F4 as well for that reason (see Appendix plates 31-41).

8.2.2 Squares E5 and F4

The total sample size of Square E5 is 219 pieces, and that of Square F4 is 48 (Table 282). Layers 28A and 27A have about an equal amount of pieces, and Layer 26A have about half of that. Square F4 consists of material from Layer 28 (no identification of whether A or B), and Layer 32. The sample from Layer 28 is twice as large as that of Layer 32 (Table 283).

Square	Frequency	Percent
E5	219	82.0
F4	48	18.0
Total	**267**	**100.0**

Table 282 - Ksar Akil Square E5 and F4 - Total sample by square

		Unit	
		E5	F4
		Count	Count
Level	XXVIA	51	0
	XXVIIA	81	0
	XXVIII	0	33
	XXVIIIA	87	0
	XXXII	0	15
	Subtotal	**219**	**48**

Table 283 - Ksar Akil Squares E5 and F4, levels 26a, 27a, 28, 28a, and 32 - Total sample by level

8.2.3 Square E5

I will concentrate on Square E5, levels 26a, 27a, and 28a, as this makes comparison with Marks and Volkman's (1986) study possible. The sample of Square E5, levels 26a, 27a, and 28a consists of 62 cores, and 157 flakes, including tools (Table 284). Among the retouched pieces, there are 17 core-on-flakes. Like in the previous chapters, I will deal mostly, but not exclusively, with whole flakes. When excluding all broken flakes from the Square E5 assemblage, the layers are reduced by 40%, 45% and 45% for layers 26A, 27A, and 28A, respectively (Table 285).

		Level		
		XXVIA	XXVIIA	XXVIIIA
		Count	Count	Count
Data Class	Core	16	28	18
	CoreOnFlake	0	3	14
	RetouchedFlake	6	7	9
	UnretouchedFlake	27	38	29
	Tool	2	5	15
	Multi-Tool	0	0	2
	Subtotal	**51**	**81**	**87**

Table 284 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Data class by level (whole and broken)

		Level		
		XXVIA	XXVIIA	XXVIIIA
		Count	Count	Count
DataClass	CoreOnFlake	0	3	3
	RetouchedFlake	5	7	8
	UnretouchedFlake	26	32	26
	Tool	0	3	11
	Multi-Tool	0	0	0
	Subtotal	**31**	**45**	**48**

Table 285 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Data class by level (whole flakes only).

8.2.4 Taphonomic assessment and raw material

Similar to the conditions imposed by the other three housing institutions, a thorough, systematic taphonomic assessment could not be carried out due to museum-curation protocols. This impaired the possibilities for a methodical appraisal of the material in its entirety. It was still, however, possible, on a cruder scale, to appreciate the overall boundaries for indices of post-depositional damage. It was estimated the sampled material can be considered contained within the margins of a single category, i.e. that the lithics analysed from the levels chosen have all undergone the same (or similar) depositional histories. The material is therefore acknowledged to pertain from primary deposits and, consequently, are comparable analytically.

The raw material is 52.5% light grey and 26.5% dark grey, making 79% of the material of greyish hue. 6.4% is considered orange, with 8% multicoloured. Shades of brown was noted as well as 3% white.

8.2.4.1 Thermal alteration and Recycling

12 pieces have been identified as having been recycled (Table 286), e.g. showing different patterns of patination on flake scars. Mostly this is noticed on cores, which is not surprising, as a core blank discarded by one knapper could potentially be used by another. Most of these cores are from Level 27A. Two cores show evidence of thermal alteration, i.e. damage by burning. Unfortunately, the lack of contextual information precludes any further investigation into this matter.

				Level		
				XXVIA	XXVIIA	XXVIIIA
				Count	Count	Count
DataClass	Core	Recycled	No	14	21	17
			Yes	2	7	1
	CoreOnFlake	Recycled	No	0	3	14
			Yes	0	0	0
	RetouchedFlake	Recycled	No	6	7	9
			Yes	0	0	0
	UnretouchedFlake	Recycled	No	27	36	29
			Yes	0	2	0
	Tool	Recycled	No	2	5	15
			Yes	0	0	0
	Multi-Tool	Recycled	No	0	0	2
			Yes	0	0	0

Table 286 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Recycled pieces. Data class by level (total sample N=219)

8.3 Cores

62 cores are included in my sample from Square E5 (Table 287). Level 27A is best represented with 28 cores, while levels 26A and 28A have 16 and 18, respectively. While there are both prepared and unprepared cores in every level, there is a clear difference in distribution (Table 288). The earliest stratigraphic level (28A) has an equal number of prepared and unprepared cores. The middle level (27A) has three times as many prepared cores than unprepared, and also have five pieces considered to be simple prepared Levallois, i.e. not conforming to the traditional, techno-typological "check-list" designed by Boëda (1986, 1995), but still clearly being exploited through planned reduction (Bolton 2015). Level 26A only have one unprepared core to its 15 prepared cores. It is possible that the distribution of cores is an artefact of my sampling, but a transition towards an increase in

prepared core reduction from levels 28A to 26A is reflected in the analysis by Marks and Volkman (1986: 11). As perceptions of Levallois technology was, and to some extent still is, tainted by inter-observer variability, and considering the much-reduced sample size in the present study, I will focus on my own data in this chapter.

8.3.1 Blank type

Half of the cores can be identified as having been made on nodules, rising to 70% when including shattered nodules (Table 289). A few cores have possibly been made on larger flakes, and some were unidentifiable. The distribution is mostly similar across the three levels (Table 290). Looking at blank type by preparation by level, it appears the distribution follows much the same pattern (Table 291).

		Level		
		XXVIA	XXVIIA	XXVIIIA
		Count	Count	Count
Data class	Core	16	28	18

Table 287: - Ksar Akil Square E5, levels 26a, 27a, and 28a - All cores by level

		Level		
		XXVIA	XXVIIA	XXVIIIA
		Count	Count	Count
Levallois	Yes	15	17	9
	Simple	0	5	0
	No	1	6	9
	Subtotal	**16**	**28**	**18**

Table 288 - Ksar Akil Square E5, levels 26a, 27a, and 28a - All prepared (Levallois), simple-prepared (Levallois), and unprepared cores by level

	Frequency	Percent
Nodule	33	53.2
Flake	3	4.8
Thermal/Frost flake	1	1.6
Shattered Nodule	10	16.1
Indeterminate	15	24.2
Total	**62**	**100.0**

Table 289 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Core blanks by blank type

		Level		
		XXVIA	XXVIIA	XXVIIIA
		Count	Count	Count
Blank type	Nodule	10	15	8
	Flake	0	3	0
	Thermal/Frost flake	1	0	0
	Shattered Nodule	0	3	7
	Indeterminate	5	7	3
	Subtotal	**16**	**28**	**18**

Table 290 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Core blanks. Blank type by level.

				Level		
				XXVIA	XXVIIA	XXVIIIA
				Count	Count	Count
Levallois	Yes	Blank Type	Nodule	9	11	5
			Flake	0	2	0
			Thermal/Frost flake	1	0	0
			Shattered Nodule	0	0	3
			Indeterminate	5	4	1
	Simple		Nodule	0	2	0
			Flake	0	1	0
			Indeterminate	0	2	0
	No		Nodule	1	2	3
			Shattered Nodule	0	3	4
			Indeterminate	0	1	2

Table 291 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Core blanks. Blank type by preparation by level.

8.3.2 Core assemblage size by layer

Although the sample size of the cores is not substantial, it is worth examining their dimensions (tables 292-294, 295-297, 298-300).

8.3.3 All cores

Looking at both prepared and unprepared cores together (tables 292-294), one can observe that cores from levels 28A and 26A both have approximately the same length and width. Cores from Level 27A are smaller in length and width than cores from the two other levels. Cores from Level 28A are considerably thicker than both 27A and 26A cores. Taken together, cores in all three levels are square, i.e. similar length and width.

		Minimum	Maximum	Mean	Total N
Level	XXVIA	29.44	74.39	52.56	16
	XXVIIA	29.42	62.26	45.05	28
	XXVIIIA	34.32	84.74	50.12	18

*Table 292 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Min, Max, and **Mean** for length for **all cores**.*

		Minimum	Maximum	Mean	Total N
Level	XXVIA	36.20	67.16	49.39	16
	XXVIIA	26.53	64.97	46.33	28
	XXVIIIA	37.62	71.90	49.92	18

*Table 293 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Min, Max, and **Mean** for width for **all cores**.*

		Minimum	Maximum	Mean	Total N
Level	XXVIA	12.16	32.84	20.39	16
	XXVIIA	11.37	40.90	21.90	28
	XXVIIIA	18.74	53.46	27.65	18

*Table 294 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Min, Max, and **Mean** for thickness for **all cores**.*

8.3.3.1 Unprepared core size

Unprepared cores, analysed separately, all have one thing in common: they are all on average slightly wider than they are long (tables 295-297). Only one unprepared core is included in the sample from level 26A, but has been included in the assessment. This core and the cores from levels 28A are close in length but the one from Level 26A is much wider. Level 27A cores are relatively square, while the specimen from Level 26A is elongated, with Level 28A cores falling in the middle. On average, unprepared cores from all three levels have the same thickness.

		Minimum	Maximum	Mean	Total N
Level	XXVIA	50.93	50.93	50.93	1
	XXVIIA	29.42	56.27	42.52	6
	XXVIIIA	34.32	84.74	47.13	9

*Table 295 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Min, Max, and **Mean** for length for **unprepared cores**.*

		Minimum	Maximum	Mean	Total N
Level	XXVIA	59.59	59.59	59.59	1
	XXVIIA	26.53	64.97	43.97	6
	XXVIIIA	37.62	71.90	51.15	9

*Table 296 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Min, Max, and **Mean** for width for **unprepared cores**.*

		Minimum	Maximum	Mean	Total N
Level	XXVIA	29.36	29.36	29.36	1
	XXVIIA	15.49	40.90	27.58	6
	XXVIIIA	18.74	53.46	30.80	9

*Table 297 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Min, Max, and **Mean** for thickness for **unprepared cores**.*

8.3.3.2 Prepared core size

For the prepared (and semi-prepared) cores, the specimens from levels 28A and 26A are slightly elongated, compared to cores from level 27A which are square (tables 298-300). Cores from Level 28A are slightly thicker than those from levels 27A and 26A, which are of relatively equal thickness.

		Minimum	Maximum	Mean	Total N
Level	XXVIA	29.44	74.39	52.67	15
	XXVIIA	35.79	62.26	45.74	22
	XXVIIIA	41.00	67.67	53.11	9

Table 298 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Min, Max, and ***Mean*** *for length for* ***prepared cores.***

		Minimum	Maximum	Mean	Total N
Level	XXVIA	36.20	67.16	48.71	15
	XXVIIA	33.37	64.88	46.97	22
	XXVIIIA	39.88	56.41	48.69	9

Table 299 - Ksar Akil Square E5, levels 26a, 27a, and 28a Min, Max, and ***Mean*** *for width for* ***prepared cores.***

		Minimum	Maximum	Mean	Total N
Level	XXVIA	12.16	32.84	19.80	15
	XXVIIA	11.37	32.40	20.35	22
	XXVIIIA	18.82	30.37	24.50	9

Table 300 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Min, Max, and ***Mean*** *for thickness for* ***prepared cores.***

8.3.4 Cortex retention for unprepared cores

More than half of the unprepared cores are completely decorticated, with another 37% having only few traces remaining (Table 301). Only about 6% retain up to 50% cortex. Because of the small sample size, not much variation in cortex retention is visible between levels (Table 302).

Cortex retention on surface	Frequency	Percent
0%	9	56.3
>0-25%	6	37.5
>25-50%	1	6.3
Total	**16**	**100.0**

Table 301 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Cortex retention on surface area of unprepared cores

		Level		
		XXVIA	XXVIIA	XXVIIIA
		Count	Count	Count
Cortex on surface area of core	0%	1	4	4
	>0-25%	0	2	4
	>25-50%	0	0	1
	ca50%	0	0	0
	50-75%	0	0	0
	>75%	0	0	0

Table 302 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Cortex retention on surface area of unprepared cores by level

8.3.5 Unprepared core technology and reduction

8.3.5.1 Overall core reduction method for unprepared cores

Characterization of overall core reduction method finds more than half the cores to possess discoidal affinities through alternate knapping (Table 303). However, only five out of nine can be said to be truly discoidal (table 305), requiring more than 60% of a core's circumference to have been exploited using alternate knapping (McNabb 2007:325). The remaining cores, appearing in the table as discoidal, do not meet the 60% exploitation cut-off, but have been knapped using alternate flaking. Migrating platform cores are also prominent, with only one single platform core.

Looking at the distribution across the three levels, no pattern is noticeable other than the observation that most of the unprepared core sample is found in the two older assemblages, due to the fact that the level 26A sample mostly is made up of prepared cores (Table 304).

Characterization of overall core reduction method	Frequency	Percent
SinglePlatformUnprepared	1	6.3
MigratingPlatform	6	37.5
Discoidal	9	56.3
Total	**16**	**100.0**

Table 303 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Characterization of overall core reduction method in unprepared cores

	Level		
	XXVIA	XXVIIA	XXVIIIA
Characterization of overall core reduction method	Count	Count	Count
SinglePlatformUnprepared	0	0	1
BipolarUnprepared	0	0	0
MigratingPlatform	0	2	4
Discoidal	1	4	4
Indeterminate	0	0	0

Table 304 - Ksar Akil Square E5, levels 26a, 27a, and 28a - characterization of overall core reduction method in unprepared cores by level

		Level		
		XXVIA	XXVIIA	XXVIIIA
		Count	Count	Count
Discoidal	Yes	1	1	3
	No	15	27	15

Table 305 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Discoidal cores

8.3.6 Core episodes, flake removals, and reduction intensity for unprepared cores

Number of core episodes for all unprepared cores range between one to four with almost two thirds having just one (Table 306). Four episodes of reduction are more common than three, and only one core has two core episodes. When this is viewed from each level, two core episodes are the mean (Table 307). Total number of removals for unprepared cores range between five and nineteen (Table 308) with a mean of eleven (Table 309).

Number of core episodes	Frequency	Percent
1	10	62.5
2	1	6.3
3	2	12.5
4	3	18.8
Total	**16**	**100.0**

Table 306 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Total number of core episodes for all unprepared cores

		Minimum	Maximum	Mean	Total N
Level	XXVIA	1	1	1	1
	XXVIIA	1	4	2	6
	XXVIIIA	1	4	2	9

*Table 307 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Min, Max, and **Mean** of core episodes for all unprepared cores by level*

Number of removals	Frequency	Percent
5	2	12.5
6	1	6.3
7	2	12.5
8	2	12.5
11	1	6.3
12	1	6.3
14	2	12.5
15	3	18.8
16	1	6.3
19	1	6.3
Total	**16**	**100.0**

Table 308 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Total number of removals for all unprepared cores.

		Minimum	Maximum	Mean	Total N
Level	XXVIA	15	15	15	1
	XXVIIA	5	19	11	6
	XXVIIIA	6	16	11	9

Table 309 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Min, Max, and ***Mean*** *of removals for all unprepared cores.*

8.3.7 Core size compared to largest flake detachment

As with the dimension of the unprepared cores as described above, the largest flake scars visible on the cores are somewhat square with an average of 22-25 mm for Level 27A, and 26-27 mm for level 28A (tables 310-311).

		Minimum	Maximum	Mean	Total N
Level	XXVIA	19.82	19.82	19.82	1
	XXVIIA	18.91	30.62	22.30	6
	XXVIIIA	14.36	43.44	27.56	9

*Table 310 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Size of largest flake scar **length** for all unprepared cores.*

		Minimum	Maximum	Mean	Total N
Level	XXVIA	29.93	29.93	29.93	1
	XXVIIA	13.27	36.76	24.92	6
	XXVIIIA	17.12	40.05	26.24	9

*Table 311 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Size of largest flake scar **width** for all unprepared cores.*

8.3.8 Prepared core reduction and technology

8.3.8.1 Preparatory flake scars

Number of preparatory scars on the striking platform surface of Levallois cores range quite significantly from four to twenty-four (Table 312). However, across the three levels, the mean is between 11-13 preparatory scars (Table 313). Similarly, looking at number of preparatory scars on the flaking surfaces of the Levallois cores, there is a comparable span of detachments (Table 314). For this side of the cores, the average of scars is also even between the levels, ranging from 8-10 (Table 315).

Number of preparatory scars	Frequency	Percent
4	3	6.5
6	3	6.5
7	2	4.3
8	5	10.9
9	3	6.5
10	4	8.7
11	1	2.2
12	1	2.2
13	1	2.2
14	10	21.7
15	5	10.9
16	3	6.5
19	1	2.2
20	2	4.3
21	1	2.2
24	1	2.2
Total	**46**	**100.0**

Table 312 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Number of preparatory scars on striking platform surface (all cores)

		Minimum	Maximum	Mean	Total N
Level	XXVIA	6	21	13	15
	XXVIIA	4	24	12	22
	XXVIIIA	6	16	11	9

*Table 313 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Min, Max, and **Mean** of Number of Preparatory Scars on Striking Platform Surface by level*

Number of preparatory scars	Frequency	Percent
3	2	4.3
5	4	8.7
6	7	15.2
7	4	8.7
8	9	19.6
9	5	10.9
10	3	6.5
11	2	4.3
12	1	2.2
13	2	4.3
14	3	6.5
15	3	6.5
17	1	2.2
Total	**46**	**100.0**

Table 314 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Number of preparatory scars on flaking surface (all cores)

		Minimum	Maximum	Mean	Total N
Level	XXVIA	3	17	10	15
	XXVIIA	3	15	8	22
	XXVIIIA	6	14	8	9

*Table 315 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Min, Max and **Mean** of Number of Preparatory Scars on Flaking Surface by level*

8.3.8.2 Numbers and Dimensions of Definite End Products

Number of definite Levallois products detached from the final flaking surface of a core goes from none to three (Table 316). Just over half the cores have had only one Levallois product detached, while 20% have had two. A prominent number of cores seem to have been abandoned with no flakes taken off the final flaking surface. On average, cores from Level 27A have had two products detached while for the two other levels one flake is the norm (Table 317).

Looking at the dimensions of the final Levallois products, three flake shapes can be tentatively identified, although all are approaching a square shape (tables 318-319). Flakes from Level 28A can be said to be wider than they are long. Products from Level 27A are essentially square. Flakes from Level 26A approach a shape in which they are slightly longer than they are wide. However, broadly speaking, the cores are fairly square.

Number of definite Levallois products	Frequency	Percent
0	8	17.4
1	26	56.5
2	9	19.6
3	3	6.5
Total	**46**	**100.0**

Table 316 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Number of definite Levallois products detached from final flaking surface

		Minimum	Maximum	Mean	Total N
Level	XXVIA	0	2	1	15
	XXVIIA	0	3	2	22
	XXVIIIA	0	1	1	9

*Table 317 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Min, Max, and **Mean** of Number of Definite Levallois Products Detached from Final Flaking Surface by level*

		Minimum	Maximum	Mean	Total N
Level	XXVIA	12.48	59.13	28.55	12
	XXVIIA	8.69	37.33	23.65	21
	XXVIIIA	16.08	37.49	25.94	7

Table 318 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Min, Max, and ***Mean*** *of dimensions of final Levallois product* ***length*** *by level*

		Minimum	Maximum	Mean	Total N
Level	XXVIA	11.61	39.78	24.94	12
	XXVIIA	10.72	37.15	22.82	21
	XXVIIIA	19.37	37.52	27.91	7

Table 319 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Min, Max, and ***Mean*** *of dimensions of final Levallois product* ***width*** *by level*

8.3.8.3 Methods of Preparation and Exploitation of Final Flaking Surface

Method of preparation of final flaking surface is almost exclusively centripetal in level 26A (Table 320). In Level 27A, the centripetal method is present in just over half the cores, while in Level 28A, it represents just one third.

Common for the method of exploitation of the final flaking surface of the Levallois cores from all three levels, is the observation that a large number of them seem to have been fully exhausted by time of discard (Table 321). Consequently, two thirds of the cores from Level 26A are either considered unexploited, or re-prepared but unexploited, or having produced a failed final removal. For level 27A, this number is half (50%). In Level 28A, almost 75% of the cores have evidence for a failed removal or unexploited final surface.

Table 322 takes a look at possible patterns between method of preparation of final flaking surface and method of exploitation of final flaking surface. Not much can be gleaned other than the possible significance that failed final removals in levels 26A and 27A mostly comes from cores with centripetal preparation, while for Level 28A, these come from bipolar-prepared cores.

		Level		
		XXVIA	XXVIIA	XXVIIIA
		Count	Count	Count
Method of preparation of final flaking surface	Unipolar	0	1	0
	Bipolar	0	0	3
	ConvergentUnipolar	0	2	1
	Centripetal	12	12	3
	UnidirectionalLateral	0	1	0
	BipolarLateral	0	0	1
	Indeterminate	3	6	1
	Subtotal	**15**	**22**	**9**

Table 320 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Method of preparation of final flaking surface

		Level		
		XXVIA	XXVIIA	XXVIIIA
		Count	Count	Count
Method of exploitation of final flaking surface	Unexploited	1	1	1
	Lineal	4	4	2
	UnipolarRecurrent	0	2	0
	BipolarRecurrent	1	2	0
	CentripetalRecurrent	0	6	0
	Re-preparedUnexploited	4	0	2
	FailedFinalRemoval	5	7	4
	Indeterminate	0	0	0
	Subtotal	**15**	**22**	**9**

Table 321 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Method of exploitation of final flaking surface

		Level		
		XXVIA	XXVIIA	XXVIIIA
		Count	Count	Count
Evidence of earlier flaking surface	Yes	11	4	2
	No	4	18	7

Table 322 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Evidence of earlier flaking surface

8.3.8.4 Earlier Flaking Surface and End Product Morphology from Final Flaking Surface

Evidence of an earlier flaking surface is highly present on cores from Level 26A, making up two thirds, while from the two earlier levels only about 25% of each core assemblage shows this feature (Table 323).

Morphology of Levallois products from the final flaking surface of a core mirror the evidence from table 34. Level 26A cores preserve evidence for five detached Levallois flakes, but also twice as many failed attempts (Table 324). Level 27A has 50% unexploited or failed removals, and Level 28A has just 25% successful detachments.

			Method of preparation of final flaking surface											
			XXVIA				XXVIIA					XXVIIIA		
			Cent.	Indet.	Unip.	Con. Uni.	Cent.	Unidir. Lat.	Indet.	Bip.	Con. Uni.	Cent.	Bip. Lat.	Indet.
			N	N	N	N	N	N	N	N	N	N	N	N
Method of exploitation of final flaking surface	XXVIA	Unexploited	1	0	0	0	0	0	0	0	0	0	0	0
		Lineal	3	1	0	0	0	0	0	0	0	0	0	0
		Bipolar Recurrent	1	0	0	0	0	0	0	0	0	0	0	0
		Reprepared Unexploited	3	1	0	0	0	0	0	0	0	0	0	0
		Failed Final Removal	4	1	0	0	0	0	0	0	0	0	0	0
		Subtotal	**12**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	XXVIIA	Unexploited	0	0	0	1	0	0	0	0	0	0	0	0
		Lineal	0	0	0	0	2	0	2	0	0	0	0	0
		Unipolar Recurrent	0	0	0	0	1	0	1	0	0	0	0	0
		Bipolar Recurrent	0	0	0	0	2	0	0	0	0	0	0	0
		Centripetal Recurrent	0	0	0	0	4	0	2	0	0	0	0	0
		Failed Final Removal	0	0	1	1	3	1	1	0	0	0	0	0
		Subtotal	**0**	**0**	**1**	**2**	**12**	**1**	**6**	**0**	**0**	**0**	**0**	**0**
	XXVIIIA	Unexploited	0	0	0	0	0	0	0	0	0	0	1	0
		Lineal	0	0	0	0	0	0	0	0	1	1	0	0
		Reprepared Unexploited	0	0	0	0	0	0	0	0	0	1	0	1
		Failed Final Removal	0	0	0	0	0	0	0	3	0	1	0	0
		Subtotal	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**1**	**3**	**1**	**1**

*Table 323 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Method of preparation of final flaking surface **by** Method of exploitation of final flaking surface **by** level*

		Level		
		XXVIA	XXVIIA	XXVIIIA
		Count	Count	Count
Morphology of Levallois products from final flaking surface	Unexploited	5	1	3
	Flake	5	10	1
	Point	0	1	1
	Blade	0	0	0
	Overshot	0	1	0
	Failed	5	9	4
	Indeterminate	0	0	0
	Subtotal	**15**	**22**	**9**

Table 324 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Morphology of Levallois products from final flaking surface

8.3.8.5 Cortex retention and distribution

Extent of cortex on the striking platform surface of a core ranges from none to more than 75% (Table 325). In Level 26A, two thirds of the cores are completely decorticated. This number is about half in Level 27A and 28A. The portion (here termed position) of cortex on the striking platform surfaces range from sporadic to extensive coverage (Table 326).

		Level		
		XXVIA	XXVIIA	XXVIIIA
		Count	Count	Count
Extent of cortex on striking platform surface	0%	10	8	4
	>0-25%	1	3	5
	>25-50%	1	2	0
	ca50%	0	6	0
	50-75%	2	0	0
	>75%	1	3	0

Table 325 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Extent of cortex on striking platform surface

		Level		
		XXVIA	XXVIIA	XXVIIIA
		Count	Count	Count
Portion of cortex on striking platform surface	None	10	8	4
	One Edge Only	1	2	1
	More Than one Edge	0	0	0
	Central	1	5	2
	Central and one Edge	0	2	2
	Central and More than one Edge	3	5	0

Table 326 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Portion of cortex on striking platform surface

8.3.8.6 Remnant Distal Ends on Striking Platform Surface

Remnant distal ends on striking platform surfaces are most prominent on cores from Level 26A, where it is calculated to 80% (Table 327). In the two older levels, this number is 50%.

		Level		
		XXVIA	XXVIIA	XXVIIIA
		Count	Count	Count
Remnant distal ends on striking platform surface	Yes	12	11	4
	No	3	11	5

Table 327 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Remnant distal ends on striking platform surface

8.4 Flakes

8.4.1 Flake assemblage size by layer

The total flake sample assemblage numbers 157 (Table 328). Level 28A is twice the size as Level 26A with level 27A in the middle. Considering only whole flakes, the number is reduced to 124 (Table 329). The variation of number of flakes in each level stay more or less the same, with layer 28A decreasing slightly.

Level	Frequency	Percent
XXVIA	35	22.3
XXVIIA	53	33.8
XXVIIIA	69	43.9
Total	**157**	**100.0**

Table 328 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Flakes by level (All flakes, whole and broken)

Level	Frequency	Percent
XXVIA	31	25.0
XXVIIA	45	36.3
XXVIIIA	48	38.7
Total	**124**	**100.0**

Table 329 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Flakes by level (whole)

8.4.2 Flake assemblage by techno-typology

Looking at the techno-typological make-up of the three levels, what is most significant is the amount of core-on-flakes in Level 28A compared to the other two levels (Table 330). Secondly, level 28A is richer in tools. This number is upheld when only the whole-flake assemblage is consulted (Table 331).

		Level		
		XXVIA	XXVIIA	XXVIIIA
		Count	Count	Count
Data Class	Core-on-Flake	0	3	14
	Retouched Flake	6	7	9
	Unretouched Flake	27	38	29
	Tool	2	5	15
	Multi-Tool	0	0	2
	Subtotal	**35**	**53**	**69**

Table 330 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Flakes by data class
All flakes, whole and broken, unretouched and retouched, including core-on-flakes

		Level		
		XXVIA	XXVIIA	XXVIIIA
		Count	Count	Count
Data Class	CoreOnFlake	0	3	3
	RetouchedFlake	5	7	8
	UnretouchedFlake	26	32	26
	Tool	0	3	11
	Multi-Tool	0	0	0
	Subtotal	**31**	**45**	**48**

Table 331 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Flakes by data class
Whole flakes, unretouched and retouched, Core-on-Flakes

8.4.3 Flake dimensions

8.4.3.1 Length, length P, width, thickness

Flakes follow about the same signature as do the cores when dimensions are examined (tables 332-334). Flakes from levels 28A and 26A are about the same **length**, with those of Level 27A being marginally shorter on average. Flakes from Level 28A are more elongated, with those of levels 27A and 26A having the same elongation. Flakes from Level 26A are wider than those of levels 28A and 27A, which have the same **width**. Level 26A flakes are also marginally thicker than levels 28A and 27A flakes, which have the same **thickness**.

	N	Minimum	Maximum	Mean
MaxLength	31	39.44	89.35	58.3361
FlakeLengthP	31	34.36	82.04	54.2371
MaxWidth	31	19.31	56.92	39.6761
MaxThickness	31	4.90	25.06	11.6477

Table 332 - Level 26A: Min, Max, and Mean of Flake Length Max, Flake Length P, Width and Thickness

	N	Minimum	Maximum	Mean
MaxLength	43	31.42	110.04	54.2288
FlakeLengthP	43	28.65	108.28	51.3002
MaxWidth	43	17.14	54.11	35.3163
MaxThickness	43	2.67	28.45	10.1630

Table 333 - Level 27A: Min, Max, and Mean of Flake Length Max, Flake Length P, Width and Thickness

	N	Minimum	Maximum	Mean
MaxLength	47	30.33	91.36	57.7147
FlakeLengthP	47	21.36	88.45	55.4009
MaxWidth	47	17.76	66.09	34.7953
MaxThickness	47	3.62	21.29	9.7483

Table 334 - Level 28A: Min, Max, and Mean of Flake Length Max, Flake Length P, Width and Thickness

8.4.3.2 Core to flake correlation

Viewed in context with the Ksar Akil core assemblages presented above, an interesting deviation from the trends of the previous three site assemblages described in chapters 5, 6, and 7 is noticeable.

It appears that when mean flake size is compared to mean core size, discarded flakes are visibly larger than discarded cores. Following the assumption from earlier chapters – that correspondence between mean flake size (e.g. mean 'max flake length') and mean core size (e.g. core 'max length') constitute circumstantial evidence for the possibility of on-site core reduction – such behavioural inference cannot readily be concluded for the Ksar Akil levels under investigation here, as will be discussed below.

As can be seen from the analysis, this is the case any which way the core and flake material is divided up: unprepared and prepared (including simple prepared) cores together, or unprepared and prepared (including simple prepared) cores separately. Whether non-Levallois flakes are correlated with unprepared cores, or Levallois flakes are correlated with prepared (including simple prepared) cores. Even if unprepared and prepared (including simple prepared) cores are correlated with all whole flakes, the result is the same, namely that the flakes from each of the sampled layers are always larger than the sampled core assemblage.

While mean volume (length x width x thickness) of discarded unprepared cores and prepared (including simple prepared) cores differ noticeably between the three layers, the mean volume (length x width x thickness) of whole Levallois and Non-Levallois flakes is remarkably consistent, except the sample of non-Levallois flakes from layer 26A, which are almost twice as large.

8.4.3.3 Platform length and width

Recording of **platform length and width** are important in estimating original size of flake blank in retouched pieces (tables 335-336). The flakes from the three levels show similar figures, but a few points can be made. Level 26A flakes are slightly narrower in platform width than flakes from the other two levels. Flakes from levels 28A and 27A are equally broad. Flakes from all three levels have the same average thickness. With the addition of proximal flakes, most counts are slightly increased (tables 337-338).

		Total N	Minimum	Maximum	Mean
Level	XXVIA	27	3.83	33.02	16.28
	XXVIIA	42	5.55	44.36	21.22
	XXVIIIA	43	7.21	45.40	23.30

Table 335 - Min, Max, and Mean of Flake Platform Width (whole flakes)

		Total N	Minimum	Maximum	Mean
Level	XXVIA	27	1.63	15.71	5.94
	XXVIIA	42	2.11	12.47	6.46
	XXVIIIA	43	1.56	15.17	7.16

Table 336 - Min, Max, and Mean of Flake Platform Thickness (whole flakes)

		Total N	Minimum	Maximum	Mean
Level	XXVIA	30	3.83	33.02	16.25
	XXVIIA	47	5.55	44.36	21.29
	XXVIIIA	52	7.21	45.40	23.49

Table 337 - Min, Max, and Mean of Flake Platform Width (whole and proximal flakes)

		Total N	Minimum	Maximum	Mean
Level	XXVIA	30	1.63	18.73	6.31
	XXVIIA	47	2.11	12.47	6.79
	XXVIIIA	52	1.56	15.17	7.16

Table 338 - Min, Max, and Mean of Flake Platform Thickness (whole and proximal flakes)

8.4.4 Dorsal indices of flakes

8.4.4.1 Dorsal scar count

On average, the same amount of flake scars is manifest on the **dorsal surface** of flakes (Table 339 and Figure 75). However, flakes from the lowermost level (28A) only have half the range of number of scars compared to the two other levels (i.e. max 11 scars in Level 28A compared to max 21 scars in Level 26A).

		Minimum	Maximum	Mean	Total N
Level	XXVIA	2	21	6	31
	XXVIIA	1	17	6	45
	XXVIIIA	0	11	6	48

Table 339 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Min, Max, and Mean for dorsal scar count. All 3 units.

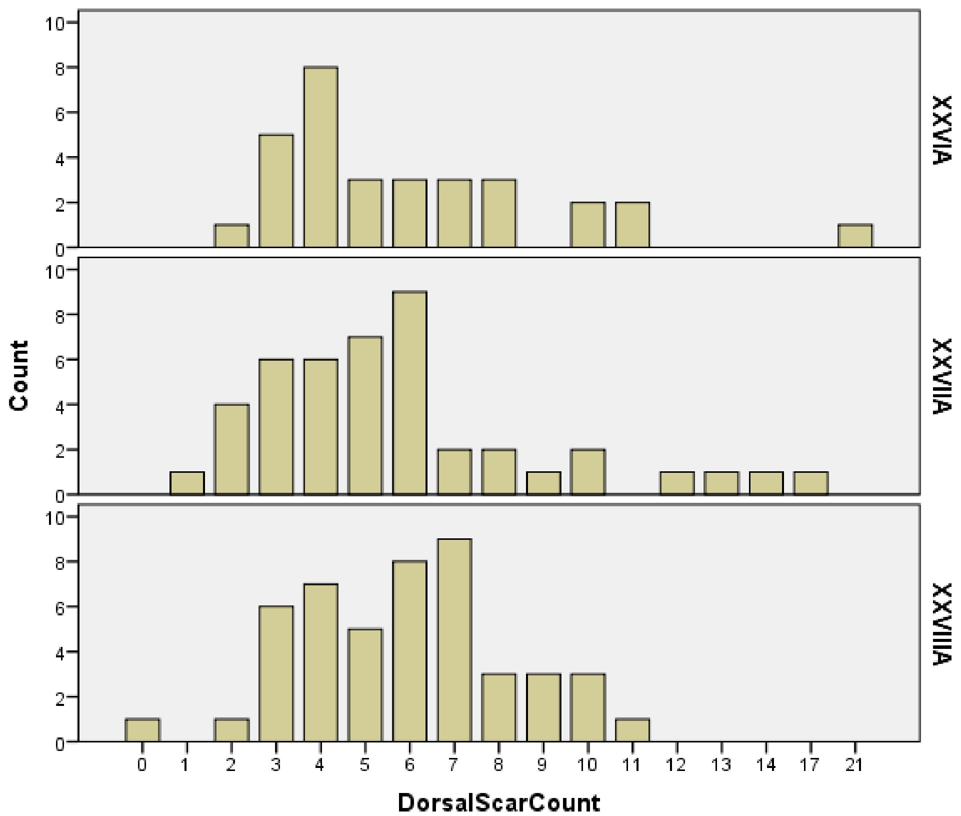

Figure 75 -Ksar Akil Square E5, levels 26a, 27a, and 28a - Dorsal scar count

8.4.4.2 Dorsal scar pattern

Looking at **dorsal scar pattern**, the patterning is quite similar for all three levels (Table 340 and Figure 76). There is an even spread of unidirectional and more complex radial patterns among all the flakes of all three individual levels, which would suggest that more extended knapping activities were carried out within each level.

		Level		
		XXVIA	XXVIIA	XXVIIIA
		Count	Count	Count
Dorsal scar pattern	Proximal	3	8	5
	Right	0	1	0
	BidirectionalProximalDistal	3	1	0
	BidirectionalLateral	0	2	0
	IndeterminateUni-BidirProximalDistal	4	8	9
	Multi-directional	4	8	5
	WeaklyRadial	4	1	9
	StronglyRadial	2	1	4
	Indeterminate(but radial)	3	3	1
	ArrisedRadial	1	0	0
	WhollyCortical	0	0	1
	Obscured	0	1	1
	Indeterminate	7	11	13
	Subtotal	**31**	**45**	**48**

Table 340 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Dorsal scar pattern

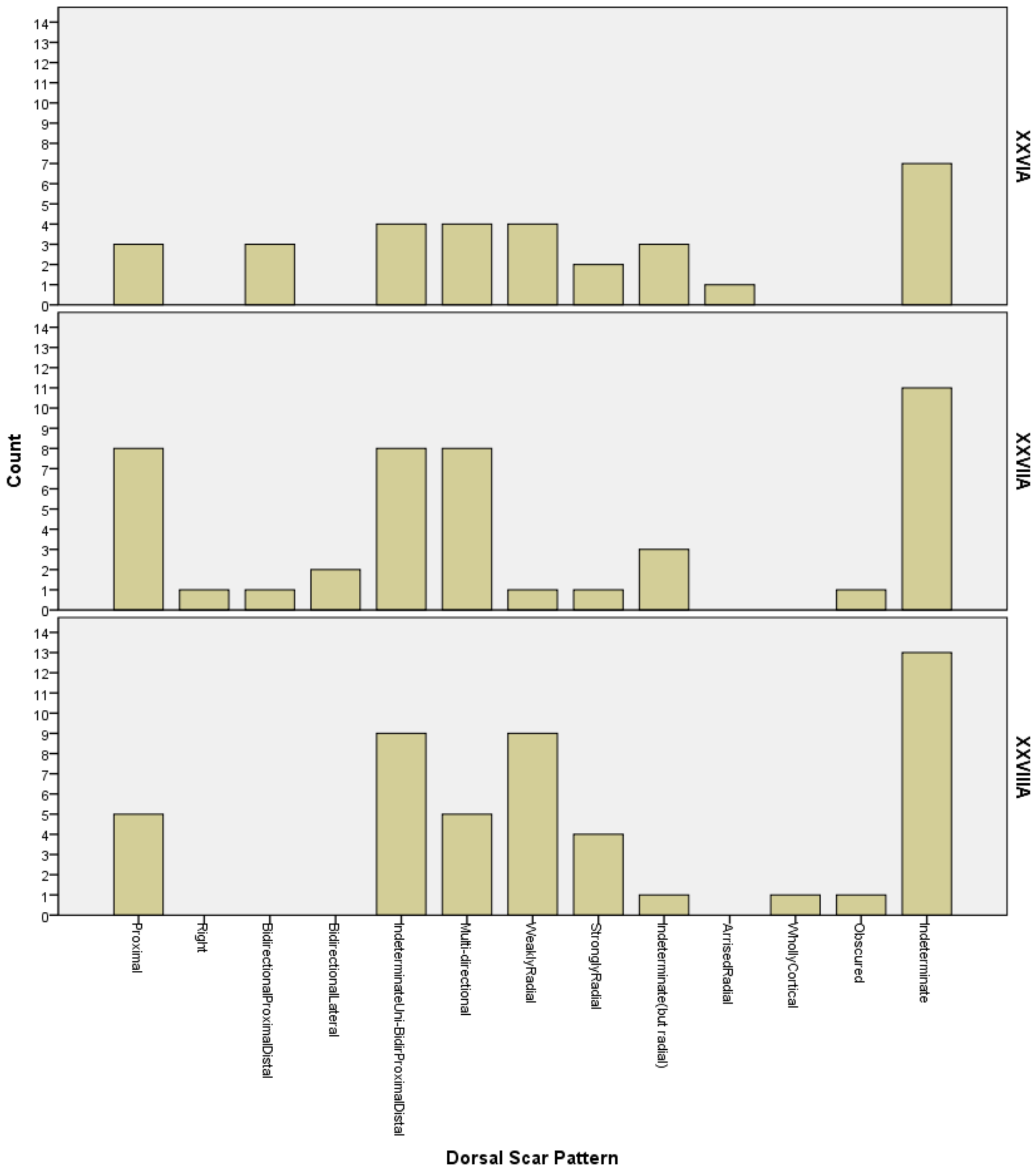

Figure 76 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Dorsal scar pattern

8.4.4.3 Dorsal cortex and cortex location

All three levels show a comparable picture for **dorsal cortex retention** (Table 341 and Figure 77). Between 60-70% are completely decorticated, with an additional ca 15-20% having up to less than 25%. This adds up to between 80-90% of each level retaining little or no cortex. This is more clearly illustrated in Table 342 and Figure 78. The **location of the cortex** is almost exclusively on the dorsal surface (Table 343 and Figure 79).

		Level					
		XXVIA		XXVIIA		XXVIIIA	
		Count	N %	Count	N %	Count	N %
Dorsal cortex on flake	0%	19	61.3%	29	64.4%	35	72.9%
	1-25%	7	22.6%	10	22.2%	7	14.6%
	26-50%	3	9.7%	4	8.9%	3	6.3%
	ca50%	1	3.2%	2	4.4%	2	4.2%
	51-75%	1	3.2%	0	0.0%	0	0.0%
	76-99%	0	0.0%	0	0.0%	0	0.0%
	100%	0	0.0%	0	0.0%	1	2.1%
	Subtotal	**31**	**100.0%**	**45**	**100.0%**	**48**	**100.0%**

Table 341 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Dorsal cortex on flake

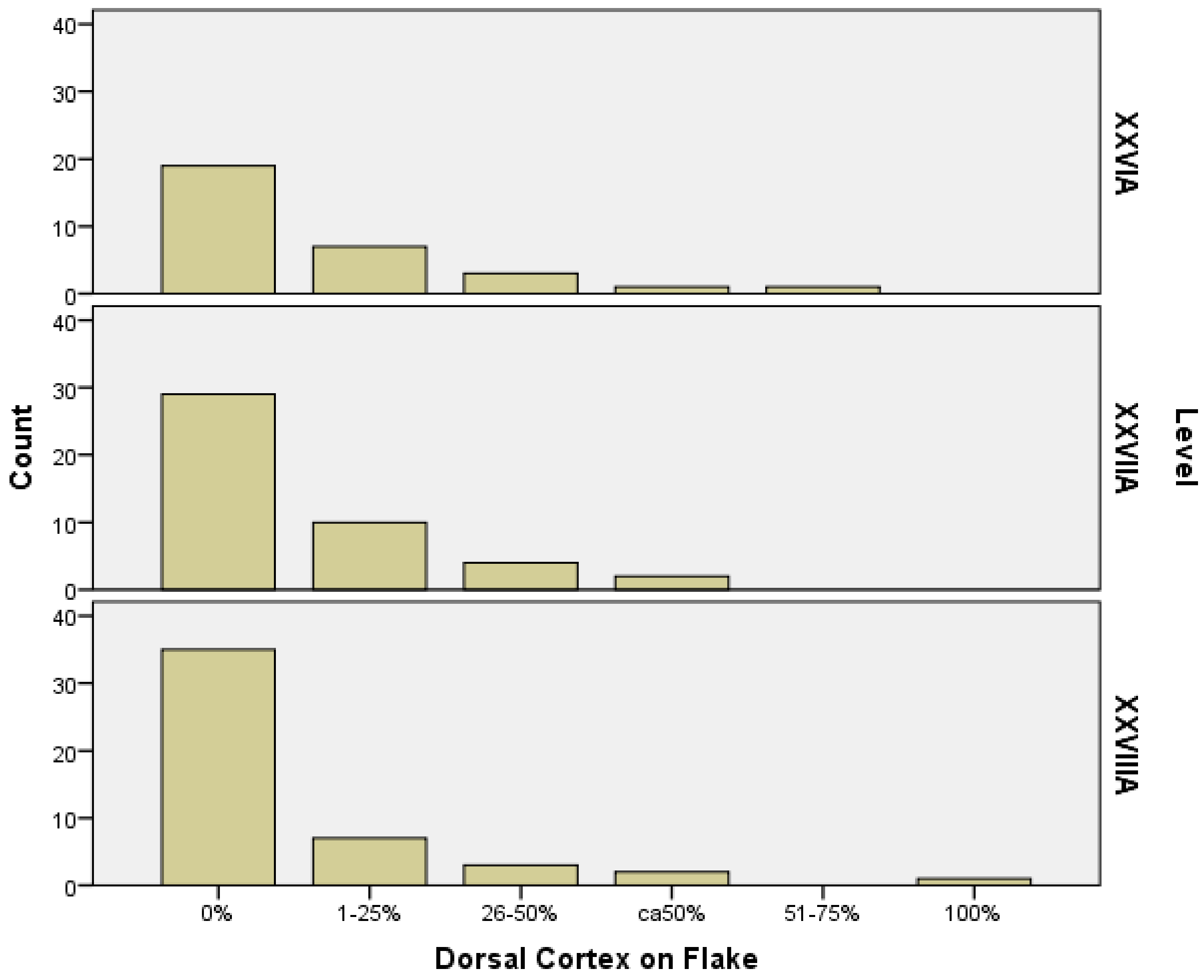

Figure 77 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Dorsal cortex on flake

		Level					
		XXVIA		XXVIIA		XXVIIIA	
		Count	N %	Count	N %	Count	N %
Dorsal cortex on flake: 3 groups	0-25%	26	83.9%	39	86.7%	42	87.5%
	25-75%	5	16.1%	6	13.3%	5	10.4%
	75-100%	0	0.0%	0	0.0%	1	2.1%

Table 342 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Dorsal cortex on flake grouped in 3 clusters

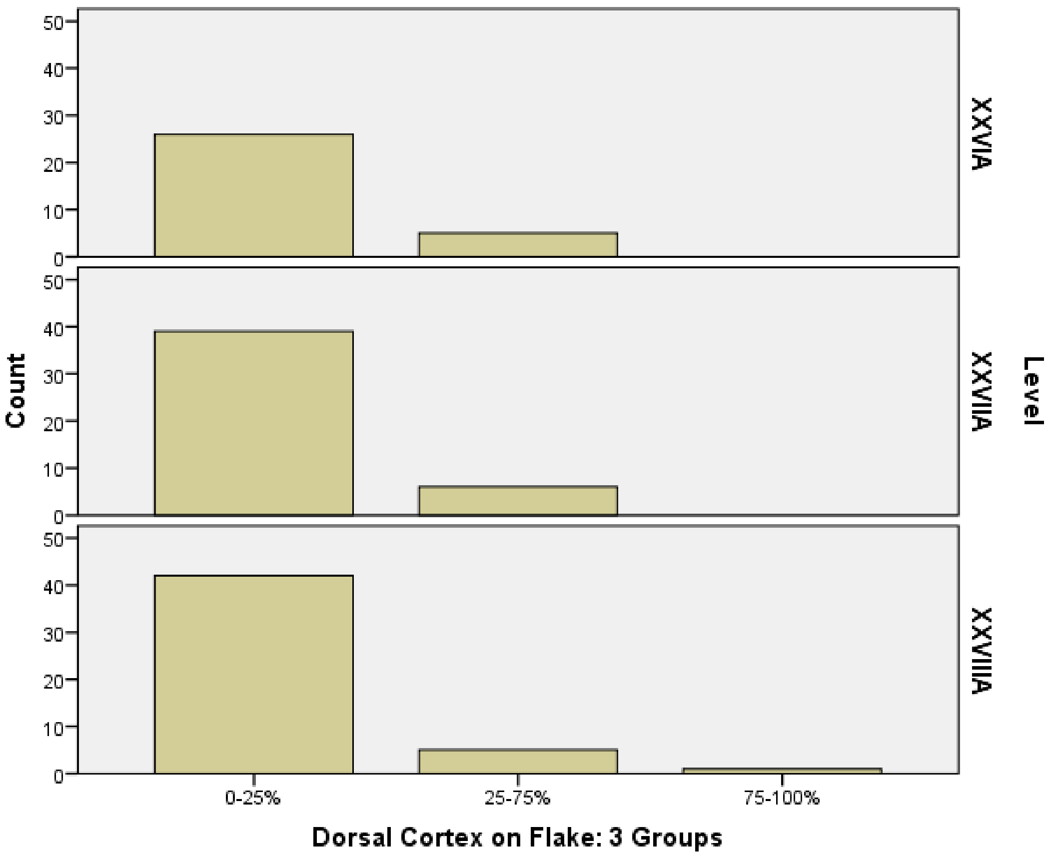

Figure 78 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Dorsal cortex on flake grouped in 3 clusters

		Level					
		XXVIA		XXVIIA		XXVIIIA	
		Count	N %	Count	N %	Count	N %
Flake cortex location	Dorsal only	12	38.7%	15	33.3%	13	27.1%
	Platform only	0	0.0%	1	2.2%	0	0.0%
	Dorsal.and platform	0	0.0%	0	0.0%	0	0.0%
	None	19	61.3%	29	64.4%	35	72.9%

Table 343 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Flake cortex location

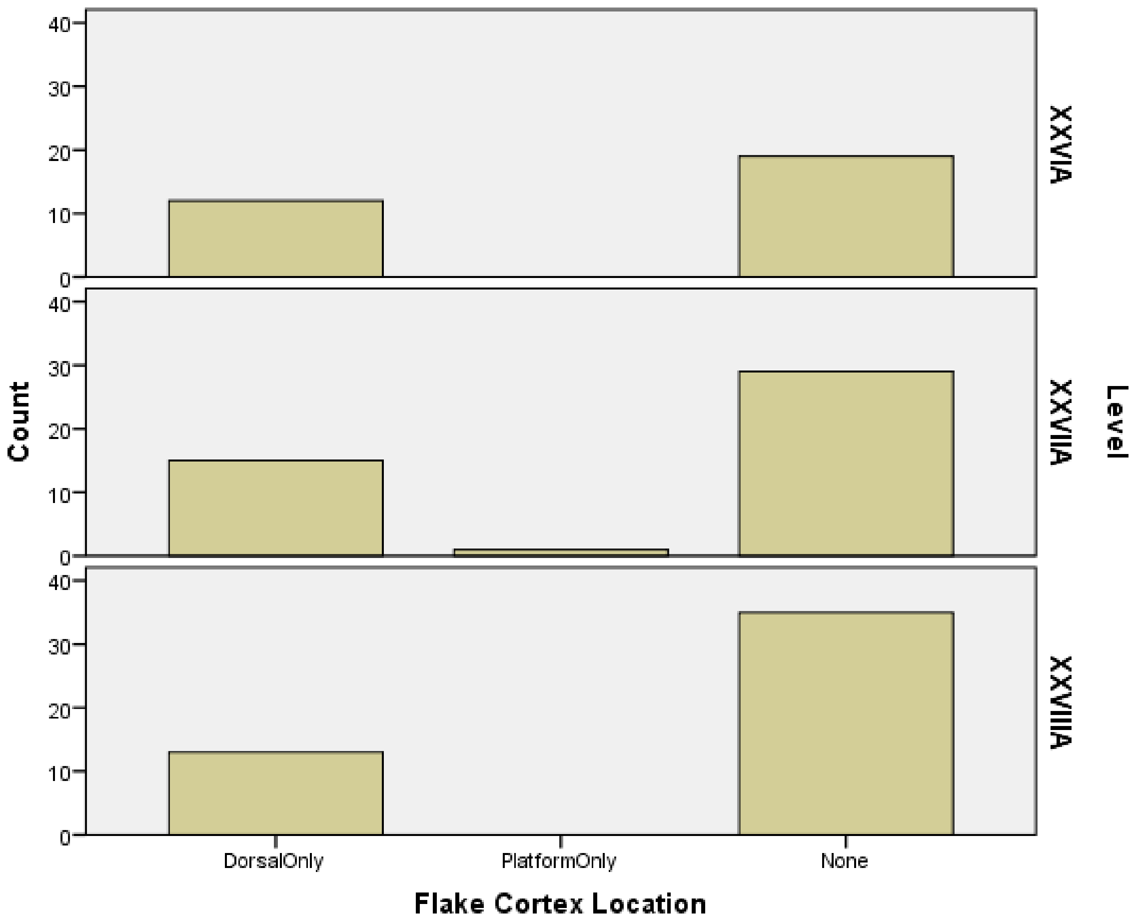

Figure 79 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Flake cortex location

8.4.5 Proximal indices of flakes

8.4.5.1 Butt type/platform

Platform preparations or affinities are much the same among the three levels (Table 344 and Figure 80). Plain and facetted butts are most common among the identifiable with the latter occupying between 50-60% of the assemblage. Ca. 15-20% in each level are obscured, and a few are retouched. In Level 28A, there is a small amount of dihedral butts present. These figures do not change significantly when introducing the population of proximal pieces (Table 345 and Figure 81).

		Level					
		XXVIA		XXVIIA		XXVIIIA	
		Count	N %	Count	N %	Count	N %
Butt type	Plain	5	16.1%	7	15.6%	4	8.3%
	Dihedral	1	3.2%	0	0.0%	4	8.3%
	Cortical	0	0.0%	1	2.2%	0	0.0%
	Natural	0	0.0%	0	0.0%	1	2.1%
	Marginal	0	0.0%	1	2.2%	0	0.0%
	Mixed	1	3.2%	0	0.0%	0	0.0%
	Facetted	16	51.6%	26	57.8%	28	58.3%
	Missing	0	0.0%	0	0.0%	1	2.1%
	Trimmed	0	0.0%	0	0.0%	0	0.0%
	Obscured	6	19.4%	6	13.3%	7	14.6%
	Retouched	2	6.5%	3	6.7%	2	4.2%
	Chapeau de Gendarme	0	0.0%	1	2.2%	1	2.1%
	Subtotal	**31**	**100.0%**	**45**	**100.0%**	**48**	**100.0%**

Table 344 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Butt types (whole flakes)

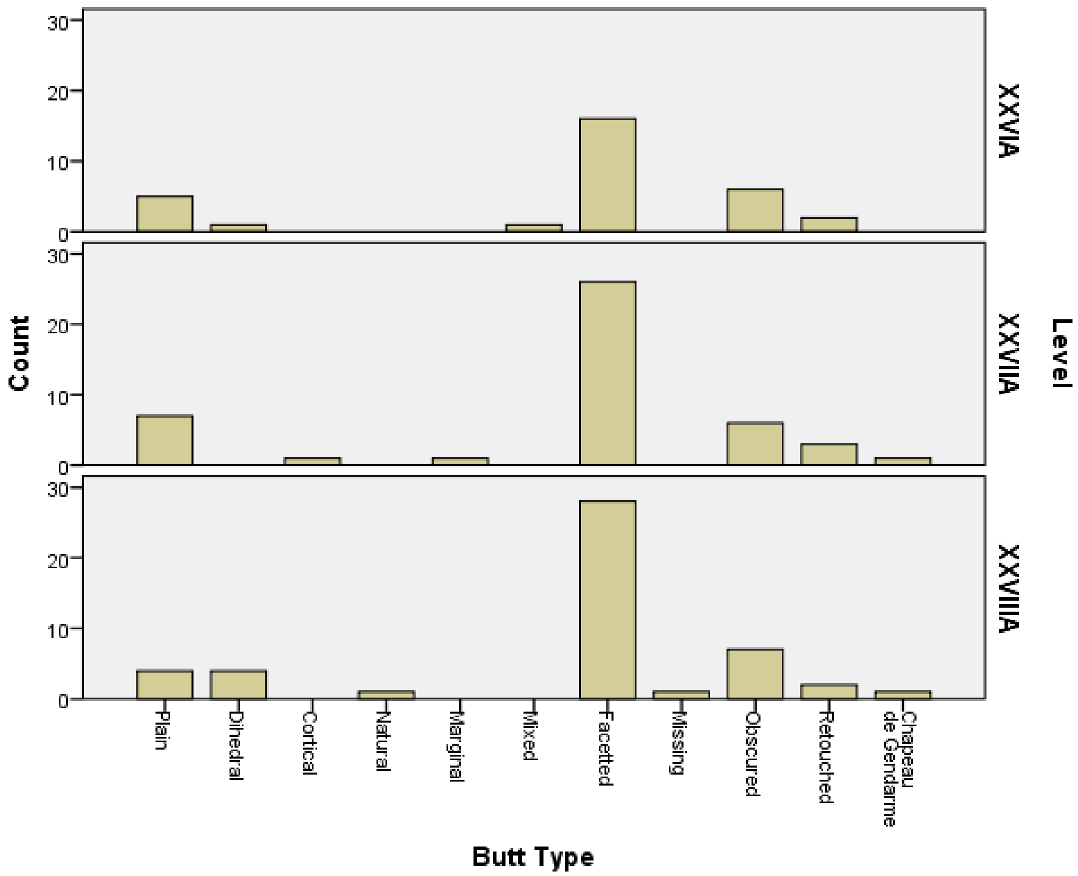

Figure 80 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Butt types (whole flakes)

		Level					
		XXVIA		XXVIIA		XXVIIIA	
		Count	N %	Count	N %	Count	N %
Butt type	Plain	5	14.7%	7	14.0%	7	12.3%
	Dihedral	1	2.9%	0	0.0%	4	7.0%
	Cortical	0	0.0%	1	2.0%	0	0.0%
	Natural	0	0.0%	0	0.0%	1	1.8%
	Marginal	0	0.0%	1	2.0%	0	0.0%
	Mixed	2	5.9%	0	0.0%	0	0.0%
	Facetted	18	52.9%	31	62.0%	32	56.1%
	Missing	0	0.0%	0	0.0%	1	1.8%
	Trimmed	0	0.0%	0	0.0%	0	0.0%
	Obscured	6	17.6%	6	12.0%	7	12.3%
	Retouched	2	5.9%	3	6.0%	3	5.3%
	Chapeau de Gendarme	0	0.0%	1	2.0%	2	3.5%
	Subtotal	**34**	**100.0%**	**50**	**100.0%**	**57**	**100.0%**

Table 345 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Butt types (whole and proximal)

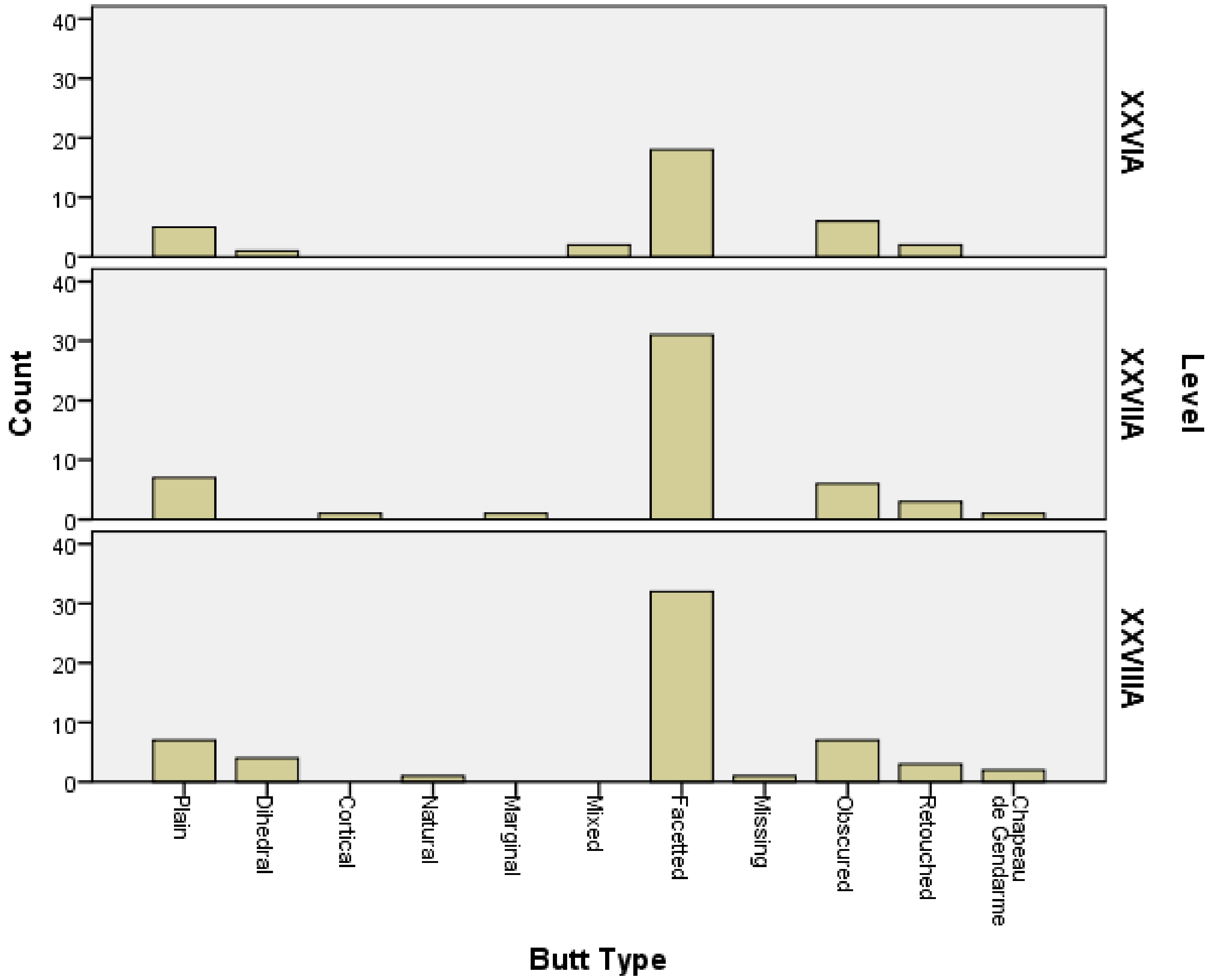

Figure 81 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Butt types (whole and proximal)

8.4.6 Distal indices of flakes

8.4.6.1 Flake termination

A bit more variability is present when examining **flake terminations** (Table 346 and Figure 82). While feather terminations by far are the most widespread, they are slightly more common in levels 28A and 27A, where they reach around 70%, against around half in Level 26A. On the other hand, plunging terminations are more common in Level 26A compared to the two other levels. So is step breaks. Levels 26A and 27A show similar figures for hinge terminations, three times higher than those of Level 28A.

		Level					
		XXVIA		XXVIIA		XXVIIIA	
		Count	N %	Count	N %	Count	N %
Flake termination	Feather	16	51.6%	31	68.9%	35	72.9%
	Hinge	4	12.9%	5	11.1%	2	4.2%
	Step(break/snap)	3	9.7%	2	4.4%	2	4.2%
	Plunging/Overshot	8	25.8%	6	13.3%	6	12.5%
	Axial	0	0.0%	0	0.0%	0	0.0%
	Retouched	0	0.0%	1	2.2%	3	6.3%
	Subtotal	**31**	**100.0%**	**45**	**100.0%**	**48**	**100.0%**

Table 346 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Flake termination

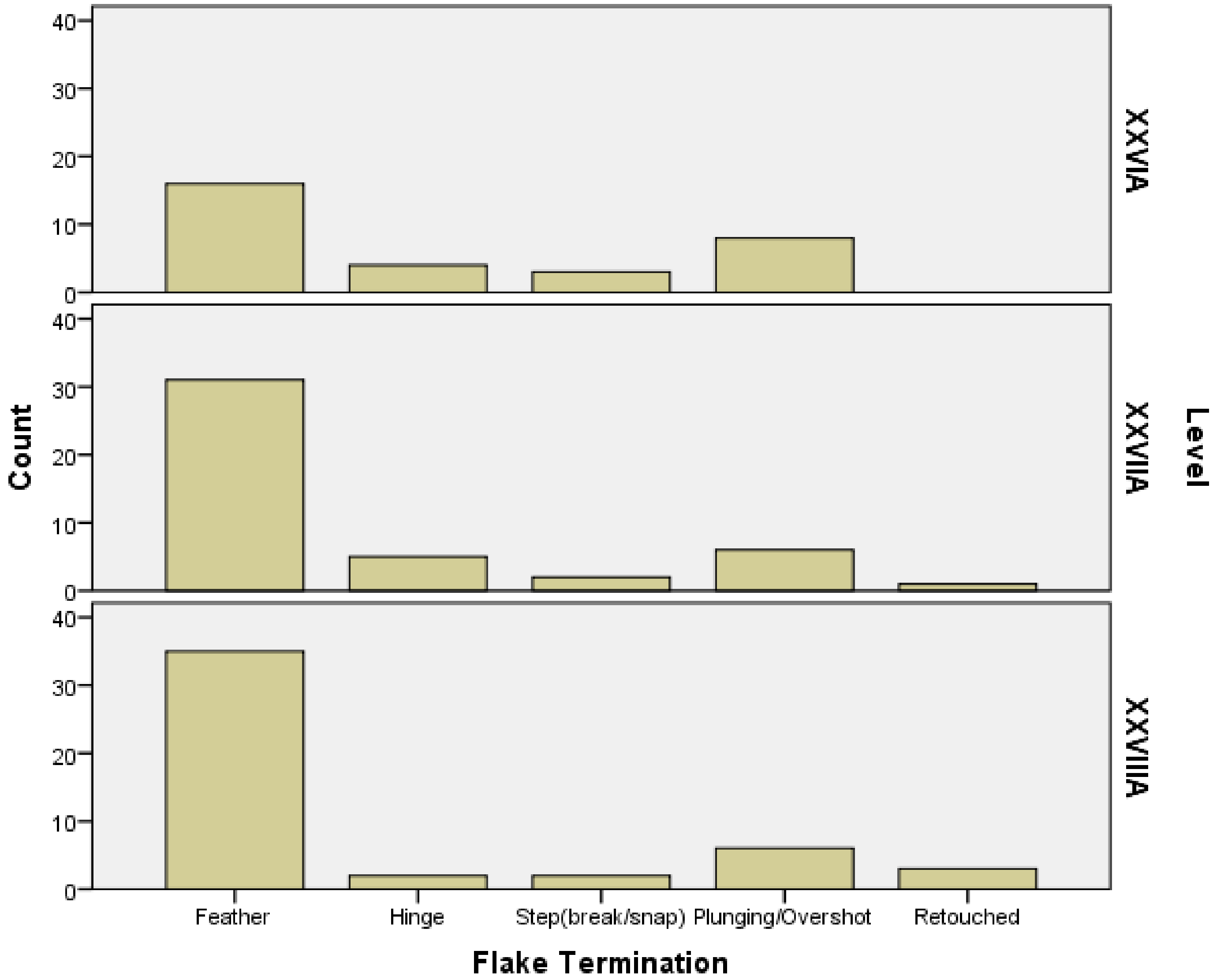

Figure 82 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Flake termination

8.4.6.2 Pointed flakes

Naturally pointed flakes, i.e. pointed through detachment, constitute 25% of the Level 28A assemblage. For Level 27A that is about 10% and for Level 26A about 6% (Table 348). Level 26A have a similar amount of flakes pointed by retouch.

		Level					
		XXVIA		XXVIIA		XXVIIIA	
		Count	N %	Count	N %	Count	N %
Pointed	YesDebitage	2	6.5%	5	11.1%	12	25.0%
	YesBreak/Snap	0	0.0%	0	0.0%	1	2.1%
	YesRetouch	2	6.5%	0	0.0%	2	4.2%
	No	27	87.1%	40	88.9%	33	68.8%
	Subtotal	**31**	**100.0%**	**45**	**100.0%**	**48**	**100.0%**

Table 347 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Pointed flakes

8.4.6.3 Redirection flakes

Interestingly, **redirection flakes** are uncommon in all three assemblages (Table 347). With the amount of flakes with complex dorsal scar patterns, one could have assumed this category to be better represented. An explanation could be that either these flakes were not curated by the excavators, or the complex dorsal scar patterns are the result of either reduction of already highly reduced cores being brought into the site, or the result of re-sharpening of tools.

		Level					
		XXVIA		XXVIIA		XXVIIIA	
		Count	N %	Count	N %	Count	N %
Redirection	Yes	1	3.2%	1	2.2%	0	0.0%
	No	30	96.8%	44	97.8%	48	100.0%
	Subtotal	**31**	**100.0%**	**45**	**100.0%**	**48**	**100.0%**

Table 348 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Redirection flakes

8.4.7 Retouch

8.5.7.1 Retouched to Unretouched Flakes

Retouched pieces are relatively common in all three whole-flake assemblages, but more so in the older Level 28A than in the younger Level 26A (Table 349). When all flakes are considered (inclusion of broken flakes), the distribution of retouched pieces to unretouched pieces is almost entirely the same (Table 350).

		Level					
		XXVIA		XXVIIA		XXVIIIA	
		Count	N %	Count	N %	Count	N %
Retouch	Yes	5	16.1%	9	20.0%	12	25.0%
	No	26	83.9%	36	80.0%	36	75.0%
	Subtotal	**31**	**100.0%**	**45**	**100.0%**	**48**	**100.0%**

Table 349 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Retouched flakes to non-retouched flakes (whole flakes)

		Level					
		XXVIA		XXVIIA		XXVIIIA	
		Count	N %	Count	N %	Count	N %
Retouch	Yes	7	20.0%	11	20.8%	15	21.7%
	No	28	80.0%	42	79.2%	54	78.3%
	Subtotal	**35**	**100.0%**	**53**	**100.0%**	**69**	**100.0%**

Table 350 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Retouched flakes to non-retouched flakes (whole and broken flakes)

8.4.7.2 Retouched flakes to Tools

The retouched flakes to tools ratio see Level 28A have more formal tools than retouched flakes (Table 351). The opposite is visible in Level 27A, where retouched flakes are most abundant, with an equal amount of tools and core-on-flakes. Only retouched flakes not conforming to conventional typology is found in Level 26A.

More variability is introduced when the full flake assemblage is consulted (Table 352). Most interestingly, there is a surge in core-on-flakes in Level 28A. The ratios stay the same in Level 27A, but a few tools find their way into the Level 26A segment.

		Level					
		XXVIA		XXVIIA		XXVIIIA	
		Count	N %	Count	N %	Count	N %
Data class	Core-on-flake	0	0.0%	3	23.1%	3	13.6%
	Retouched Flake	5	100.0%	7	53.8%	8	36.4%
	Tool	0	0.0%	3	23.1%	11	50.0%
	Multi-Tool	0	0.0%	0	0.0%	0	0.0%
	Subtotal	**5**	**100.0%**	**13**	**100.0%**	**22**	**100.0%**

Table 351 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Retouched flakes to tools (whole flakes)

		Level					
		XXVIA		XXVIIA		XXVIIIA	
		Count	N %	Count	N %	Count	N %
Data class	CoreOnFlake	0	0.0%	3	20.0%	14	35.0%
	RetouchedFlake	6	75.0%	7	46.7%	9	22.5%
	Tool	2	25.0%	5	33.3%	15	37.5%
	Multi-Tool	0	0.0%	0	0.0%	2	5.0%
	Subtotal	**8**	**100.0%**	**15**	**100.0%**	**40**	**100.0%**

Table 352 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Retouched flakes to tools (whole and broken flakes)

8.4.7.3 Tool Types

Formal tool counts are low in the whole-flake assemblages, but of note is the significant amount of Levallois points in Level 28A (Table 353). With fragments included, there is more variability (Table 354). Scrapers, borers, and burins augments the Levallois points.

		Level					
		XXVIA		XXVIIA		XXVIIIA	
		Count	N %	Count	N %	Count	N %
Tool type	Levallois Point	0	0.0%	1	33.3%	8	72.7%
	End Scraper	0	0.0%	1	33.3%	0	0.0%
	Borer/Bec/Priser	0	0.0%	0	0.0%	2	18.2%
	Burin	0	0.0%	0	0.0%	1	9.1%
	Notch	0	0.0%	1	33.3%	0	0.0%
	Subtotal	**0**	**0.0%**	**3**	**100.0%**	**11**	**100.0%**

Table 353 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Tool type (whole flakes)

		Level					
		XXVIA		XXVIIA		XXVIIIA	
		Count	N %	Count	N %	Count	N %
Tool type	Single Scraper	0	0.0%	1	20.0%	0	0.0%
	Levallois Point	1	50.0%	1	20.0%	12	70.6%
	End Scraper	0	0.0%	2	40.0%	0	0.0%
	Borer/Bec/Priser	0	0.0%	0	0.0%	3	17.6%
	Burin	1	50.0%	0	0.0%	1	5.9%
	Burin and Point	0	0.0%	0	0.0%	1	5.9%
	Notch	0	0.0%	1	20.0%	0	0.0%
	Subtotal	**2**	**100.0%**	**5**	**100.0%**	**17**	**100.0%**

Table 354 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Tool type (whole and broken flakes)

8.4.7.4 Retouched Area Length vs. Length of Inverse Circumference of Flake

Ratio of retouched edge to total edge length provide some interesting insight into the technological behaviour at Ksar Akil (tables 355-356). The flake blanks in Level 26A are largest on average but have the least amount of retouch. Conversely, flakes from Level 28A are the smallest on average but have the highest ratio of retouch. This would mean that while size of flake blank increases, amount of retouch decreases.

When doing this analysis for only non-tool/non-formal retouched flakes, the figures are essentially the same (tables 357-358).

Most of the retouched pieces, including tools, from all three assemblages have only one area of retouch (tables 359-361). By looking specifically at non-tool/non-formal retouched flakes, not much difference is detectable (tables 362-364).

		Total N	Minimum	Maximum	Mean
Level	XXVIA	5	115.97	203.20	158.17
	XXVIIA	9	118.56	185.45	152.98
	XXVIIIA	12	91.95	204.96	135.24

Table 355 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Length of ***inverse circumference*** *of all retouched flakes and tools, whole: including core-on-flake, retouched flakes, tools, and multi-tools.*

		Total N	Minimum	Maximum	Mean
Level	XXVIA	5	5.67	27.77	18.92
	XXVIIA	9	9.56	32.06	19.67
	XXVIIIA	12	9.00	64.61	33.68

Table 356 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Length of ***combined retouch areas*** *on all retouched flakes and tools, whole: including core-on-flake, retouched flakes, tools, and multi-tools.*

		Total N	Minimum	Maximum	Mean
Level	XXVIA	5	115.97	203.20	158.17
	XXVIIA	7	118.56	185.45	154.23
	XXVIIIA	8	91.95	194.13	130.14

*Table 357 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Length of **inverse circumference** on retouched flakes (Retouched flakes only, whole)*

		Total N	Minimum	Maximum	Mean
Level	XXVIA	5	5.67	27.77	18.92
	XXVIIA	7	9.56	32.06	18.92
	XXVIIIA	8	17.08	64.61	36.81

*Table 358 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Length of **combined retouch areas** on retouched flakes (Retouched flakes only, whole)*

Number of retouched areas	Frequency	Percent
1	5	100.0

Table 359 - Number of retouched areas for all whole retouched flakes and tools, including core-on-flakes, retouched flakes, retouched tools, and multi-tools. Level 26A

Number of retouched areas	Frequency	Percent
1	8	88.9
2	1	11.1
Total	**9**	**100.0**

Table 360 - Number of retouched areas for all whole retouched flakes and tools, including core-on-flakes, retouched flakes, retouched tools, and multi-tools. Level 27A

Number of retouched areas	Frequency	Percent
1	10	83.3
2	2	16.7
Total	**12**	**100.0**

Table 361 - Number of retouched areas for all whole retouched flakes and tools, including core-on-flakes, retouched flakes, retouched tools, and multi-tools. Level 28A

Number of retouched areas	Frequency	Percent
1	5	100.0

Table 362 - Number of retouched areas for whole retouched flakes only. Level 26A

Number of retouched areas	Frequency	Percent
1	6	85.7
2	1	14.3
Total	**7**	**100.0**

Table 363 - Number of retouched areas for whole retouched flakes only. Level 27A

Number of retouched areas	Frequency	Percent
1	6	75.0
2	2	25.0
Total	8	100.0

Table 364 - Number of retouched areas for whole retouched flakes only. Level 28A

8.4.7.5 Retouch technique

Due to the low sample size of Level 26A, not a lot of variability in **retouch technique** can be appreciated (Table 365). From levels 27A and 28A, various techniques of retouch are attested (tables 366-367).

		Level	
		XXVIA	
		Count	Column N %
Retouch Technique1	Direct	1	3.2%
	Inverse	4	12.9%
	N/A	26	83.9%
Retouch Technique2	N/A	31	100.0%
Retouch Technique3	N/A	31	100.0%
Retouch Technique4	N/A	31	100.0%

Table 365 - Level 26A: Retouch technique for retouch areas

		Level	
		XXVIIA	
		Count	Column N %
Retouch Technique1	Direct	6	13.3%
	Inverse	1	2.2%
	Alternating	1	2.2%
	CoreOnFlakeVen	2	4.4%
	CoreOnFlakeBoth	1	2.2%
	TFpProx	1	2.2%
	N/A	33	73.3%
Retouch Technique2	N/A	44	97.8%
	Direct	1	2.2%
Retouch Technique3	N/A	45	100.0%
Retouch Technique4	N/A	45	100.0%

Table 366 - Level 27A: Retouch technique for retouch areas

		Level	
		XXVIIIA	
		Count	Column N %
Retouch Technique1	Direct	9	18.8%
	Inverse	1	2.1%
	Alternating	1	2.1%
	Burination	1	2.1%
	CoreOnFlakeVen	1	2.1%
	TFpProx	2	4.2%
	N/A	33	68.8%
Retouch Technique2	Direct	1	2.1%
	Inverse	1	2.1%
	N/A	46	95.8%
Retouch Technique 3	N/A	48	100.0%
Retouch Technique4	N/A	48	100.0%

Table 367 - Level 28A: Retouch technique for retouch areas

8.4.8 Core-on-flakes

Core-on-flakes are prominently represented in Level 28A and are attested in Level 27A (tables 368-369). Core-on-flakes are usually produced though *ad hoc* knapping, but a few have been detached using prepared core technique (Table 370). It can be difficult to assess exactly what techniques have been used, and some techniques can overlap causing some to be attributed to non-core-on-flake retouch techniques (Table 371).

		Frequency	Percent
	CoreOnFlake	**17**	**10.8**
	RetouchedFlake	22	14.0
	UnretouchedFlake	94	59.9
	Tool	22	14.0
	Multi-Tool	2	1.3
	Total	**157**	**100.0**

Table 368 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Core-on-flakes ratio of total assemblage

		Level		
		XXVIA	XXVIIA	XXVIIIA
		Count	Count	Count
Data class	Core-on-Flake	0	3	14

Table 369 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Core-on-flakes by level

		Level		
		XXVIA	XXVIIA	XXVIIIA
		Count	Count	Count
Levallois	Yes	0	0	1
	Simple	0	0	1
	No	0	3	12
	Subtotal	**0**	**3**	**14**

Table 370 - Ksar Akil Square E5, levels 26a, 27a, and 28a - All core-on-flakes by preparation by level

		Level					
		XXVIA		XXVIIA		XXVIIIA	
		Count	Column N %	Count	Column N %	Count	Column N %
Retouch technique1	Direct	0	0.0%	0	0.0%	1	7.1%
	CoreOnFlakeVen	0	0.0%	2	66.7%	2	14.3%
	CoreOnFlakeBoth	0	0.0%	0	0.0%	3	21.4%
	TFpProx	0	0.0%	1	33.3%	6	42.9%
	TFpProxDist	0	0.0%	0	0.0%	2	14.3%

Table 371 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Core-on-flake by retouch technique

8.4.9 Truncated-facetted pieces

A small portion of **truncated-facetted pieces** are found in the assemblages (Table 372). As with the core-on-flakes, they are observed in the older Level 28A (Table 373).

Truncated-faceted pieces		Frequency	Percent
	Yes	**10**	**6.4**
	No	147	93.6
	Total	157	100.0

Table 372 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Truncated-facetted pieces

		Level					
		XXVIA		XXVIIA		XXVIIIA	
		Truncated-Faceted piece		Truncated-Faceted piece		Truncated-Faceted piece	
		Count	N %	Count	N %	Count	N %
Retouch tech-nique1	CoreOnFlakeBoth	0	0.0%	0	0.0%	1	11.1%
	TFpProx	0	0.0%	1	100.0%	6	66.7%
	TFpProxDist	0	0.0%	0	0.0%	2	22.2%

Table 373 - Ksar Akil Square E5, levels 26a, 27a, and 28a - ***Truncated-facetted pieces*** *by retouch technique*

8.4.10 Levallois

8.4.10.1 Levallois by whole/broken flakes

There is a very strong Levallois presence in all of the three Ksar Akil levels (Table 374). From more than half in Level 27A to two thirds in both level 28A and 26A. When considering only whole flakes the figures for levels 26A and 27A stay about the same, while Level 28A increases to an impressive 81% (Table 375).

		Level					
		XXVIA		XXVIIA		XXVIIIA	
		Count	N %	Count	N %	Count	N %
Levallois	Yes	23	65.7%	29	54.7%	45	66.2%
	No	12	34.3%	24	45.3%	23	33.8%

Table 374 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Percentage of Levallois within flake assemblage (whole and broken)

		Level					
		XXVIA		XXVIIA		XXVIIIA	
		Count	N %	Count	N %	Count	N %
Levallois	Yes	21	67.7%	27	60.0%	38	80.9%
	No	10	32.3%	18	40.0%	9	19.1%

Table 375 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Percentage of Levallois within flake assemblage (whole)

8.4.10.2 Type of Levallois product by data class

The Levallois products of the two upper levels consists mostly of unretouched flakes (Table 376). For both levels this constitutes about 80%. For Level 28A, unretouched Levallois flakes are just 50% of the assemblage. Level 28A, on the contrary, have about 30% tools, dwarfing the numbers for the two other layers who decreases chronologically. For retouched, but non-formal-tool Levallois flakes levels 28A and 26A have equal numbers of 15% and 17%, respectively, five to six times higher than Level 27A. This picture stays much the same when only examining whole flakes (Table 377).

		Level					
		XXVIA		XXVIIA		XXVIIIA	
		Count	N %	Count	N %	Count	N %
Data class	CoreOnFlake	0	0.0%	0	0.0%	2	4.3%
	RetouchedFlake	4	17.4%	1	3.4%	7	15.2%
	UnretouchedFlake	18	78.3%	25	86.2%	24	52.2%
	Tool	1	4.3%	3	10.3%	13	28.3%
	Multi-Tool	0	0.0%	0	0.0%	0	0.0%
	Subtotal	**23**	**100.0%**	**29**	**100.0%**	**46**	**100.0%**

Table 376 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Levallois by data class (whole and broken)

		Level					
		XXVIA		XXVIIA		XXVIIIA	
		Count	N %	Count	N %	Count	N %
Data class	CoreOnFlake	0	0.0%	0	0.0%	1	2.6%
	RetouchedFlake	3	14.3%	1	3.7%	7	17.9%
	UnretouchedFlake	18	85.7%	23	85.2%	22	56.4%
	Tool	0	0.0%	3	11.1%	9	23.1%
	Multi-Tool	0	0.0%	0	0.0%	0	0.0%
	Subtotal	**21**	**100.0%**	**27**	**100.0%**	**39**	**100.0%**

Table 377 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Levallois by data class (whole)

8.4.10.3 Type of Levallois product in morphological terms

The types of Levallois products in morphological terms identified for the three levels can be summarised as follows. All levels have standard Levallois flakes as their most common end product, 38%, 74%, and 52%, for levels 28A, 27A, and 26A, respectively (Table 378). However, Level 26A have almost 50% non-standard Levallois flakes such as debordant and/or overshot flakes (traditionally considered unsuccessful but serviceable), which are numbers much higher than the two lower levels. Levels 28A and 27A have evidence of metrical Levallois blade reduction, which is unattested in Level 26A.

Number of preceding Levallois removals	Frequency	Percent
0	4	19.0
1	15	71.4
2	1	4.8
3	1	4.8
Total	**21**	**100.0**

Table 378 - Level 26A Number of preceding Levallois removals

8.4.10.4 Number of preceding Levallois removals

Number of preceding Levallois removals, i.e. previously removed Levallois end products, visible on the dorsal surface of a Levallois preferential piece, are totalled in tables 379-381. Flakes in levels 28A and 26A typically have just one prior removal, while Level 27A have evidence for both one and two prior removals.

Type of Levallois product.in morphological terms		Level					
		XXVIA		XXVIIA		XXVIIIA	
		Count	N %	Count	N %	Count	N %
Type.of Levallois product.in morphological terms	Flake	11	52.4%	20	74.1%	15	39.5%
	Blade	0	0.0%	3	11.1%	5	13.1%
	Point	0	0.0%	1	3.7%	8	21.1%
	Debordant flake	4	19.0%	0	0.0%	7	18.4%
	Overshot	2	9.5%	0	0.0%	0	0.0%
	Debordant and overshot	4	19.0%	3	11.1%	3	7.9%
	Indeterminate	0	0.0%	0	0.0%	0	0.0%
	Total	**21**	**100.0%**	**27**	**100.0%**	**38**	**100.0%**

Table 379 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Type of Levallois product in morphological terms

Number of preceding Levallois removals		Frequency	Percent
	0	4	14.8
	1	11	40.7
	2	10	37.0
	3	2	7.4
	Total	**27**	**100.0**

Table 380 - Level 27A Number of preceding Levallois removals

Number of preceding Levallois removals	Frequency	Percent
0	16	41.0%
1	18	46.2%
2	3	7.7%
3	1	2.6%
Total	**38**	**100.0%**

Table 381 - Level 28A Number of preceding Levallois removals

8.4.10.5 Mode of preparation

The preparation of the Levallois end products are usually centripetal or recorded as indeterminate (Table 382). Differences between the levels are seen in Level 28A's larger amount of convergent unipolar preparation, unipolar preparation in Level 27A, and bipolar preparation in Level 26A.

	Level					
	XXVIA		XXVIIA		XXVIIIA	
Mode of preparation	Count	N %	Count	N %	Count	N %
Unipolar	0	0.0%	2	7.4%	1	2.7%
Convergent Unipolar	0	0.0%	1	3.7%	7	18.4%
Bipolar	2	9.5%	1	3.7%	0	0.0%
Centripetal	11	52.4%	7	25.9%	13	34.2%
Bipolar Lateral	0	0.0%	1	3.7%	0	0.0%
Indeterminate	8	38.1%	15	55.6%	17	44.7%
Total	**21**	**100.0%**	**27**	**100.0%**	**38**	**100.0%**

Table 382 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Mode of preparation

8.4.10.6 Mode of exploitation

Examining method of exploitation, single removals and unipolar recurrent are most prominent, with Level 28A having substantial evidence of lineal exploitation (Table 383). Evidence of repreparation is only common in Level 26A (Table 384).

Method of exploitation		Level					
		XXVIA		XXVIIA		XXVIIIA	
		Count	N %	Count	N %	Count	N %
	Lineal	1	4.8%	1	3.7%	10	26.3%
	Single Removal	6	28.6%	4	14.8%	5	13.1%
	Unipolar Recurrent	7	33.3%	16	59.3%	15	39.5%
	Bipolar Recurrent	1	4.8%	0	0.0%	0	0.0%
	Centripetal Recurrent	2	9.5%	5	18.5%	0	0.0%
	Indeterminate	4	19.0%	1	3.7%	8	21.1%
	Total	**21**	**100.0%**	**27**	**100.0%**	**38**	**%**

Table 383 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Method of exploitation

Evidence of repreparation	Level					
	XXVIA		XXVIIA		XXVIIIA	
	Count	N %	Count	N %	Count	N %
Yes	7	33.3%	0	0.0%	1	2.6%
No	14	66.7%	27	100.0%	37	97.4%
	21	100.0%	27	100.0%	38	100.0%

Table 384 - Ksar Akil Square E5, levels 26a, 27a, and 28a - Evidence of repreparation

8.5 Discussion of the Ksar Akil layer 28A, 27A, and 26A assemblages

The Levantine coastal site of Ksar Akil was included in this study in order to provide a comparative counterpoint for both

1) an assessment of the "Mousterian" Middle Palaeolithic as a technological expression in a lowland (non-montane) setting, and
2) an assessment of the techno-behavioural differences between Levantine and Zagros expressions of the "Mousterian" Middle Palaeolithic techno-complex(es). The assumption here is that particular technological choices found in the Zagros Mountains – and claimed by Lindly (1997) to be technological "Zagros Mousterian" behaviour in support of his "summer adaptation hypothesis" – need to be restricted to those montane environments, and is not reflected in a coastal low-land environment, in order for the "summer adaptation hypothesis" to be a valid proposition.

As such, 219 lithics were analysed from the Ksar Akil assemblage in the Harvard Peabody Museum collection. The material examined were levels 28A, 27A, and 26A from Unit E5.

8.5.1 Core to flake correlation and on-site core reduction

It was found that, contrary to the three other site assemblages analysed, the core and flake sample assemblages of Ksar Akil layers 28A, 27A, and 26A does not exhibit a size relationship that would readily allow for a correlation assuming the flakes could have been knapped from the cores. At least not immediately prior to the cores discard phase. Whether looking at correlation between unprepared cores and non-Levallois flakes, or prepared cores and Levallois flakes, or all cores (both unprepared, simple prepared, and prepared) with all whole flakes (both non-Levallois and Levallois), the flakes are repeatedly larger than the cores. This aspect is amplified if flake size is correlated with size of largest flake scar on cores. Here flakes are seen to be 2-3 times longer than largest flake scar length, and 1-2 times wider than largest flake scar width.

The lack of such 'direct' core and flake correlation hampers the straight assumption of on-site core reduction within Ksar Akil levels 28A, 27A, and 26A. Two interpretations can be forwarded as explanation for this circumstance. A behavioural interpretation would be suggesting that cores were taken out into the landscape during hunting and/or foraging events, and only discarded when safe return to the site is accomplished, and the need for *at hand* raw material has ended. Such interpretation, however, does not match with the specific environment and the affordances of assumed natural occurrences of raw material outcrops. A related interpretation would see the latest stages of flake production being moved off-site, hence not appearing in the record. The lack of smaller flakes could also be explained through lack of curation of smaller flakes by the excavators. This, however, seems doubtful, as similar curational strategies are expected to have influenced the original excavation of Shanidar and Warwasi.

There seems to be a trend towards more utilisation of prepared core technology from the earlier level 28A to the later level 26A. The core blanks are typically made on nodules, but core-on-flakes are attested extensively in the earlier level 28A, with a few in Level 27A. Unprepared cores are significantly bigger in volume upon discard in levels 28A and 26A than are prepared and simple prepared cores from these levels (although Level 26A only have one unprepared core). The cores in level 27A, while following the same trend, are much more equal in volume when discarded.

This could indicate that the favoured, or ideal, size of flake blank was the same, and unaffected by techno-typological reduction method. An alternative interpretation would be that any blank size under a certain size was considered too small, independent of reduction method.

8.5.1.1 Unprepared cores

Upwards of 90% of the unprepared cores have almost no cortex preserved. The picture is the same for all three levels. This would seem to suggest that in areas like the Levant where lithic raw material, generally, is more readily available than in the Zagros, evidence for exhaustion of core blank raw material (i.e. as a ratio of how much cortex is left on a core at the time of discard) is not uncommon. This issue would seem to be important for discussions of lack of cortex retention as a proxy for raw material reduction intensity as a function of raw material constraints.

About 25% of the cores are discoidal, while others are worked through alternate knapping patterns. Migrating cores are the other main core reduction method found. No discernible patterns of core reduction methods are visible between the levels, besides the fact that most cores in Level 26A are prepared. Across the levels, unprepared cores preserve evidence for an average of two core episodes, with an average of eleven removals. The largest removals from these cores are generally between 2-3 cm and square.

8.5.1.2 Prepared and simple prepared cores

The average number of preparatory scars on the striking platform surface of Levallois cores is between 11-13 and is the same across all three levels. This number is similar for scars on the flaking surfaces and are also similar across the levels. There are between one to three preferential end products detached on average from the prepared cores. Some cores show evidence of having no final preferential detachment. This might be interpreted as a sign of raw material exhaustion, which again should be surprising when found in a landscape where raw material is easy to acquire. A tentative behavioural interpretation could be that exhausted cores were only discarded when hominins returned to the site, where likely a store of raw material would have been kept. Such a scenario would be consistent with what Kuhn (1995) has termed "provisioning of places".

The cores from level 27A in general show evidence for having had two end products detached, while that number is one for the other two levels. While all Levallois products are somewhat square, there might be basis for suggesting small differences. Wider than long, square, and longer than wide, for levels 28A, 27A, and 26A, respectively.

Centripetal preparation is not common in Level 28A but increases from Level 27A to Level 26A where it is dominant. A large number of cores throughout the three levels seem to have been completely exhausted when discarded, as seen in the numbers of cores with failed final removals or repreparation without final exploitation.

The range of remnant cortex on the prepared cores, which is much higher than among the unprepared cores would suggest, that not only were the cores discarded because they could no longer support serviceable preferential Levallois products, but seemingly neither were usable for even unprepared core reduction. This is interesting in terms of raw material curation and preservation. It would seem like the cores from Level 26A were made on larger nodules than those from the preceding levels, as remnant distal ends are more common on cores from this level.

8.5.1.3 Flakes

Cortex retention show no change between levels. 60-70% of flakes are entirely decorticated, with 15-20% having no more than 25% remaining cortex. Seen together, ca. 80-90% of flakes throughout each level retain little or no cortex. This would suggest very little, if any, primary flaking have taken place in either of the three levels analysed at Ksar Akil. Conversely, the amount of complex dorsal scar patterns found in the flake population, should not necessarily be automatically equated with large amounts of on-site core reduction either. Instead, this could correspond to a signature of reduction of already much-exploited cores, being utilised for a last time before discard, after having had their main circles of exploitation out in the landscapes, before being brought back to the site. This could be corroborated by the low number of redirection flakes. Only very few redirection flakes were found in the assemblage, which taken together with the substantial amount of flakes displaying complex dorsal scar patterns could suggest not a signal of on-site reduction, but one of curation, whereby already well-used cores have been transported into the site for final exploitation. This would explain the low numbers of redirections flakes, as less core reduction would involve less core rotation, which would mean fewer new platforms, which in turn would produce fewer redirection flakes. Depending on size of flakes, it could also possibly be evidence to suggest rejuvenation of tools.

8.5.2 Retouch intensity and tool types

Retouch is common on flakes from each level, but more prominent in Level 28A than in 26A. There are more whole formal tools than whole retouched flakes in level 28A, which is the opposite from Level 27A. In the Level 26A sample, there are no whole formal tools, however, there are a few tool fragments. Level 28A also is relatively rich in core-on-flakes and have more Levallois points than the other levels. All levels have fragments of scrapers, borers, and burins.

Looking at the ratio of retouched edge to total edge length, flake blanks from Level 26A are generally largest but have the least amount of retouch. The flakes from Level 28A, on the other hand, are the smallest on average but have the highest ratio of retouch. This seems to suggest that while the size of flake blank increases, the amount of retouch decreases.

8.5.3 Technology and typology

The flakes from all three levels are generally the same size with minor differences. Flakes from Level 26A have slightly more narrow platforms than the flakes from levels 28A and 27A, but with same average thickness. Average number of dorsal flake scars is the same across levels, with an equal patterning of dorsal scar patterns. Simple and more complex dorsal patterns, (complex dorsal patterns usually seen as a proxy for progression of reduction intensity) is about equal. This corresponds to the evidence for plain and facetted butts being dominant in all assemblages.

As mentioned above, Level 28A stands out because of its core-on-flakes. It also has most of the truncated-facetted pieces identified in the sample. Core-on-flakes and truncated-facetted pieces are also found in very low numbers in Level 27A.

8.5.4 Evidence for Levallois technology and reduction within Ksar Akil layers 28A, 27A, and 26A

Levallois is very well represented in the three Ksar Akil levels analysed and constitute more than half of the Level 27A material, and two thirds of the material in Level 28A and Level 26A.

Unretouched Levallois flakes are the most common in levels 27A and 26A. In Level 28A, there are more tools together with unretouched Levallois flakes. In Level 26A, there are a lot more non-standard Levallois flakes such as debordant and/or overshot flakes than in the other levels. Hints of metric Levallois blades are found in the two older levels.

Between one and two prior Levallois removals are attested on the dorsal surface of the pieces, and preparation is frequently centripetal. The preferred method of exploitation is single removal and unipolar recurrent. In Level 28A there is considerable lineal exploitation. Level 26A is the only level with regular signs of repreparation.

8.5.5 Major insights to hominin behaviour at Ksar Akil based on data analysis

The analysis of the sample assemblages from Ksar Akil levels 28A, 27A, and 26A, was done in the context of gaining insights to technological decision-making processes within a low-land, Levantine locale, in the pursuance of comparative data with which to test the "summer adaptation hypothesis" relating to site assemblages from Zagros Mountains environments.

By examining lithic raw material exploitation and curation, core reduction, and flake modification from a site located within an environment in which neither vertical mobility is assumed to have been a key foraging strategy, nor constrictions on lithic raw material acquisition are assumed to have been naturally imposed, the identification of lithic signatures of reduction similar to those stated to be hall-marks of the "summer adaptation hypothesis" in the Zagros Mountains, would seem to challenge said hypothesis.

The fact that core-on-flakes and truncated-facetted pieces are prominent in Level 28A but absent in Level 26A would seem to suggest different approaches to lithic raw material exploitation. If truncated-facetted pieces are to be associated with a strategy of raw material exploitation that seeks to extend or stretch the threshold of lithic blanks before discard, then it would appear peculiar to find such strategy at a site, located in an environment where raw material is expected to have been plentiful. Either, the explanation is that truncated-facetted pieces *are* to be seen as a proxy for raw material conservation, in which case – with the evidence from Ksar Akil Level 28A – such signature cannot be unequivocally equated with montane environments in general and the Zagros Mousterian in particular. Or, the explanation is that truncated-facetted pieces are *not* to be seen as a proxy for raw material conservation, in which case Lindly's argument for vertical extension of raw material through truncated-facetted pieces is made invalid, or at the very least contentious.

8.6 Summary of discussion of Ksar Akil layers 28A, 27A, and 26A data analysis

Core to flake correlation, on-site core reduction

- No direct core and flake correlation
    - Flake size bigger than those of discarded cores
        - No direct evidence of on-site core reduction

Retouch intensity

- Level 28A flake blanks generally are the smallest on average but have the highest amount of retouch, while Level 26A flake blanks generally are the largest but have the least amount of retouch
    - Suggest that while the size of flake blank increases, the amount of retouch decreases

Technology and typology

- Progression of utilization of core-on-flakes/truncated-facetted pieces from significant amounts in level 28A, to few in Level 27A, to none in Level 26A.

Evidence for Levallois technology and reduction at Houmian

- Considerable quantities of Levallois in all three Ksar Akil levels
    - Two thirds of assemblage in levels 28A and 26A, and more than half of Level 27A
- Level 28A have more tools together with unretouched Levallois flakes.
- Unretouched Levallois flakes are most common in levels 27A and 26A.
- Level 26A has greater variety of non-standard Levallois flakes (debordant, overshot) than the other two levels.

Major insight to hominin behaviour at Houmian based on data analysis

- On-site core reduction not demonstrated through proxy of core and flake size correlation for either level
    - Evidence for minimum flake-size cut-off or threshold of 22.5 cm. for length and 24 cm for width
- Existence of truncated-facetted pieces in Level 28A, very few in Level 27A and non in Level 26A
    - Suggests occurrence of truncated-facetted pieces does not equate with raw material scarcity

- Suggests truncated-facetted pieces cannot be used as proxy for high-montane curation of lithic raw material

Chapter 9 - Discussion

9.1 Introduction

The main research question in this thesis was to what extent it could be refuted that the montane environments of the Zagros Mountains exclusively were being occupied by hominins during summer months in the Middle Palaeolithic. That any land-use and seasonal mobility were restricted to short annual incursions.

Skinner (1965) first proposed the idea of a distinct techno-complex adapted to the Zagros Mountains, based on typological observations, and Lindly (1997) reinforced and improved the concept, organising and rationalising the Zagros Mousterian into a distinct techno-behavioural system. This system, Lindly (1997) argued, was based on hominin adaptation to summer-seasonal exploitation of highland landscapes. His identification of such summer-seasonal adaptation, as the defining signature, was informed by inferences from the literature on Pleistocene climate and environments (Lindly 1997:30-47, 308-317), that summer seasons were the only viable window, due to temperatures otherwise being too low at the altitudes where the relevant sites were located.

Below, I will discuss the palaeoenvironmental evidence available from Houmian, and from the result of that offer a refutation of the "Summer Adaptation Hypothesis" based on environmental evidence. Subsequently, I will present a comparative analysis of the results from my data chapters. This comparative analysis will be the foundation for which I will offer a refutation of the "Summer Adaptation Hypothesis" based on techno-typological evidence.

9.2 Refutation of the "Summer Adaptation Hypothesis": the environmental evidence

The environmental evidence from Houmian is unfavourable in supporting the "Summer Adaptation Hypothesis". Below, I will argue that Lindly (1997), in my view, subscribes to a climatic-deterministic interpretation, which cannot be substantiated, and therefore undermines the "Summer Adaptation Hypothesis" entirely.

Lindly begins his section on climate reconstruction by stating: "*Climate reconstruction for the Pleistocene in the Zagros is difficult to provide*" (1997: 35). And while his ensuing presentation of contemporary climatic modelling is not uncompelling, his proposition that many of his sampled Zagros sites could, conceivably, have been covered in snow for either most of the year or "*hundreds if not thousands of years during colder periods*" (1997: 35), the opposite – that a warm phase (like the interstadial indicated at Houmian, Layer 2), hypothetically, could have enabled multi-seasonal, if not year-round, occupation – does not seem to elicit an exploration, let alone a comment. Indeed, it could almost seem as if the opposite scenario was unthinkable or unacceptable as an explanation.

9.2.1 Houmian pollen record

As mentioned previously in Chapter 2, Lindly (1997: 25-27), in my opinion, overinterprets Bewley's (1984: 35) words in a way that reflects positively on the Houmian lithic assemblage as a candidate for inclusion within the Zagros Mousterian:

"*The environmental indicators suggested a climatic amelioration during the densest occupation of the site (Layer 2a). Bewley (1984:35) suggested that because the site is located at 2000 m above sea level, it **only** could have been occupied during a warmer period and even then **only** seasonally in the summer months*." (Lindly 1997: 26; emphasis mine).

This seems to be a conscious misquotation. What Bewley originally said was:

"*The real importance of Houmian, in the archaeology of the Zagros Mountains, is that it shows there was* ***an interstadial period of climatic amelioration****, perhaps enabling the neanderthal populations to live (if only seasonally) at such a high altitude*" (Bewley 1984:35; emphasis mine).

9.2.2 Warm and cold stages

The pollen analysis of Leroi-Gourhan (1981; in Bewley 1984:30-32) more than suggested a climatic amelioration at the <u>end</u> (top) of Layer 2a. Not <u>throughout</u> Layer 2a as is inconsistently purported by Lindly (1997:26): "*The environmental indicators suggested a climatic amelioration during the densest occupation of the site (Layer 2a).*" (cf. Lindly 1997:38, 45, 46, 50). Leroi-Gourhan's pollen analysis is crucial: that while the climatic amelioration can be said to <u>*begin*</u> in Layer 2a (Two A) – the actual interstadial is not materialised until the succeeding, stratigraphically later, Layer 2 (Two).

Not only does the bulk of the Houmian lithic material originate in Layer 2a – the three-dimensional recording of the lithics in the stratigraphy by the excavator, McBurney, (Figure 16b in Bewley 1984:16; Figure 34b), shows it to be concentrated towards the <u>bottom</u> of layer 2a, <u>between the beginning and the middle of Layer 2a (not the top of Layer 2a)</u>. i.e. <u>before</u> the beginning of the climatic amelioration. This would appear to correspond to what Leroi-Gourhan (in Bewley 1984:30) identifies as "*cold steppe is altogether dominant*", what Lindly reference as "*cold and dry*" (Lindly 1997:45). Only "[a]*t the* ***end of 2a*** *there begins to be a considerable climatic fluctuation…*" implying "…*a sharp rise in temperature*" (Leroi-Gourhan in Bewley 1984:30, emphasis mine; Leroi-Gourhan 1981:76).

While the contextual geo-references, for those of the lithics recorded three-dimensionally, as mentioned previously, have unfortunately been lost, and although it therefore is impossible to disentangle which lithics within Layer 2a came from where within that layer, it *can*, based on Figure 34b, be confirmed that most of the lithics from Layer 2a can be demonstrated to originate from between towards the beginning to the middle of Layer 2a.

As this would climatically correspond to a colder phase (or at best a transitional phase towards a warmer phase) before the onset of the warmer phase towards the end of Layer 2a, ultimately manifesting in a true interstadial throughout Layer 2, the main part of the Mousterian occupation of the rockshelter necessarily must be recognised as to have taken place within a colder -*not* a warmer phase. This would significantly undermine the interpretation of Lindly (1997), who argues for a climatic scenario wherein:

"*it is reasonable to conclude that, when possible, the only feasible opportunity for occupation would have been during the brief summer season, and even then possibly only during very mild climatic periods, such as the interglacial documented during isotope stage 5e*" (1997: 308-309).

It is important to point out that the above quote from Lindly's conclusive chapter, and his mentioning of MIS 5e was in reference to his general scenario for summer-seasonal adaptation pertaining to all of his sites, i.e. the Zagros Mousterian *per se*, not in specific reference to Houmian. He does however specifically consider the Houmian pollen record as pertaining to MIS 5e, although this is not the conclusion reached by Leroi-Gourhan (1981; in Bewley 1984). Lindly states:

[MIS] "*6 was a dryer and colder period and could be related to Levels 6 through the base of Level 2 at Houmian. Level 2a, with an 80% arboreal pollen result, could have been deposited during stage 5e. The cave* [sic] *was not occupied after this period of the Middle Paleolithic, perhaps due to fluctuating climatic conditions in stage 5d to 5a and the cold conditions of stage 4. The environment was never again warm enough for an occupation at 2000 m in elevation*." (Lindly 1997: 46-47).

Lindly here poses generalising assertions that, first of all, contradict his claim cited above (Lindly 1997: 26) about the beginning of the onset of the climatic amelioration, and, surprisingly, offers the opposing interpretation of MIS 5e (i.e. last interglacial, 130,000-116,000 BP (peak ca. 123,000 BP) (Lisiecki & Raymo 2005) as the identification of the warm phase recognised by Leroi-Gourhan (1981; in Bewley 1984). Moreover, his sweeping statements about both post-Level 2a levels of occupation or site-use at the rockshelter (not cave), and predictions on climate and environmental variability, are in my opinion unsubstantiated both by his data, by Leroi-Gourhan's (1981) and Bewley's (1984) data, and by my review of potential climatic and environmental variability in the Zagros. As presented in chapter 3 the environmental and climatic regimes operating within the Zagros Mountains are immense. The forces at work are simply too complex and variable to completely refuse to entertain the scenario of multi-season (i.e. not exclusively summer) exploitation of, for example, intermontane valleys during the Pleistocene.

The specific interstadial identified for Houmian Layer 2 by Leroi-Gourhan (1981; in Bewley 1984) was considered by Leroi-Gourhan to be Brørup, at the time estimated to 63,000-60,000 BP (Leroi-Gourhan in Bewley 1984:32), but today would be considered MIS 5c, dated at ca. 105,000-95,000 BP (peak ca. 96,000 BP) (Lisiecki & Raymo 2005) or 109,000-96,000 BP (Räsänen, Auri and Ovaskainen 2021).

This could be argued to specifically indicate occupation at Houmian within a cold-phase, before the Brørup Interstadial (MIS 5c), and after the Eemian/last interglacial (MIS 5e). This would seem to fit the Herning Stadial (MIS 5d), dated at ca. 116,000-110,000 BP (peak ca. 109,000 BP) (Lisiecki & Raymo 2005), what Djamali et al. (2008) locally has termed the Espir Stadial I. I would extend the proposition of correlating the Houmian Layer 2a lithic assemblage with this stage.

The idea of a Zagros Mountains Mousterian adaptation (or even "techno-complex") materialised as a high-altitude lithic technological expression, is, in and of itself, not problematic. What is problematic, to this author, is the brittle and unsubstantiated environmentally-deterministic foundation upon which it has been situated (Lindly 1997: 316).

It is my conclusion that Lindly's claim that the Zagros Mousterian is a summer adaptation is based on a circular argument invoking circumstantial environmental proxies as grounds for not only lumping various sites' assemblages under one flag, but also restricting them to one behavioural situation. His position seems to be that 'it would have been too cold for hominins to occupy the Zagros at any other time than in the summer', while at the same time saying 'the Zagros Mousterian is a summer adaptation because it could only have been used in the summer'.

The evidence from Houmian, as seen from lithics and pollen (both individually and together in context) serves to refute the possibility for an all-encompassing, climatically-determined Zagros Mousterian techno-complex as a spatio-temporal expression of a seasonal-driven hominin mobility strategy in high montane environments. Even with the lack of sufficient proxy data for most sites, this is simply not what the data shows.

9.3 Comparative analysis between Zagros Mousterian and Levantine Mousterian assemblages

In the following comparative techno-typological analysis of the assemblages from my four sample sites, I will argue that there, on the one hand, is no defining unity between the Middle Palaeolithic techno-typological signatures among the Zagros sites justifying them being lumped together in a techno-complex, and on the other hand, that too many similarities exists between assemblages from the Zagros Mountains and the Levantine Coast for the former to be categorised as a specific techno-behavioural system, adapted to high-altitude land-use. As such, the aim of this comparative study is to be able to appreciate the fluidity of two traditionally accepted techno-complexes of southwest Asia, by demonstrating techno-typological variability between sites within the Zagros, and highlighting inter-regional techno-typological uniformity when compared to the Levantine assemblages.

9.3.1 Techno-typological affinities associated with the Zagros Mousterian: Flake dimensions

I will first look at the flake populations. It has been claimed that Zagros Mousterian debitage is comparatively short and non-laminar. Raw material constraints have been invoked as a reason for this, with the notion that continuous raw material exploitation would have gradually reduced the volume of cores as these were transported up through the highlands. This would again have led to the size of debitage becoming continually smaller. Another proxy for this claim is said to be evidenced by less remnant cortex on flakes.

9.3.1.1 Length/Width of whole flakes for all sites

Whilst the whole flakes found in Houmian, Warwasi, and Shanidar are of broadly similar size, those found in Ksar Akil are significantly larger (one-way ANOVA, $p<0.01$) (Figure 83 and Table 385). This picture is maintained when the combined Ksar Akil material is divided up into the three separate assemblages of levels 28A, 27A, and 26A (Figure 84). There were no significant differences found in the sizes of whole flakes between the three layers of Ksar Akil (one-way ANOVA, $p=0.60$).

At face value, this observation is in line with the expected result, namely that Zagros Mousterian debitage is smaller (lesser length/width totals) than those found in the Levantine Mousterian. This is further illustrated by the figures for Mean Surface Area (Table 385).

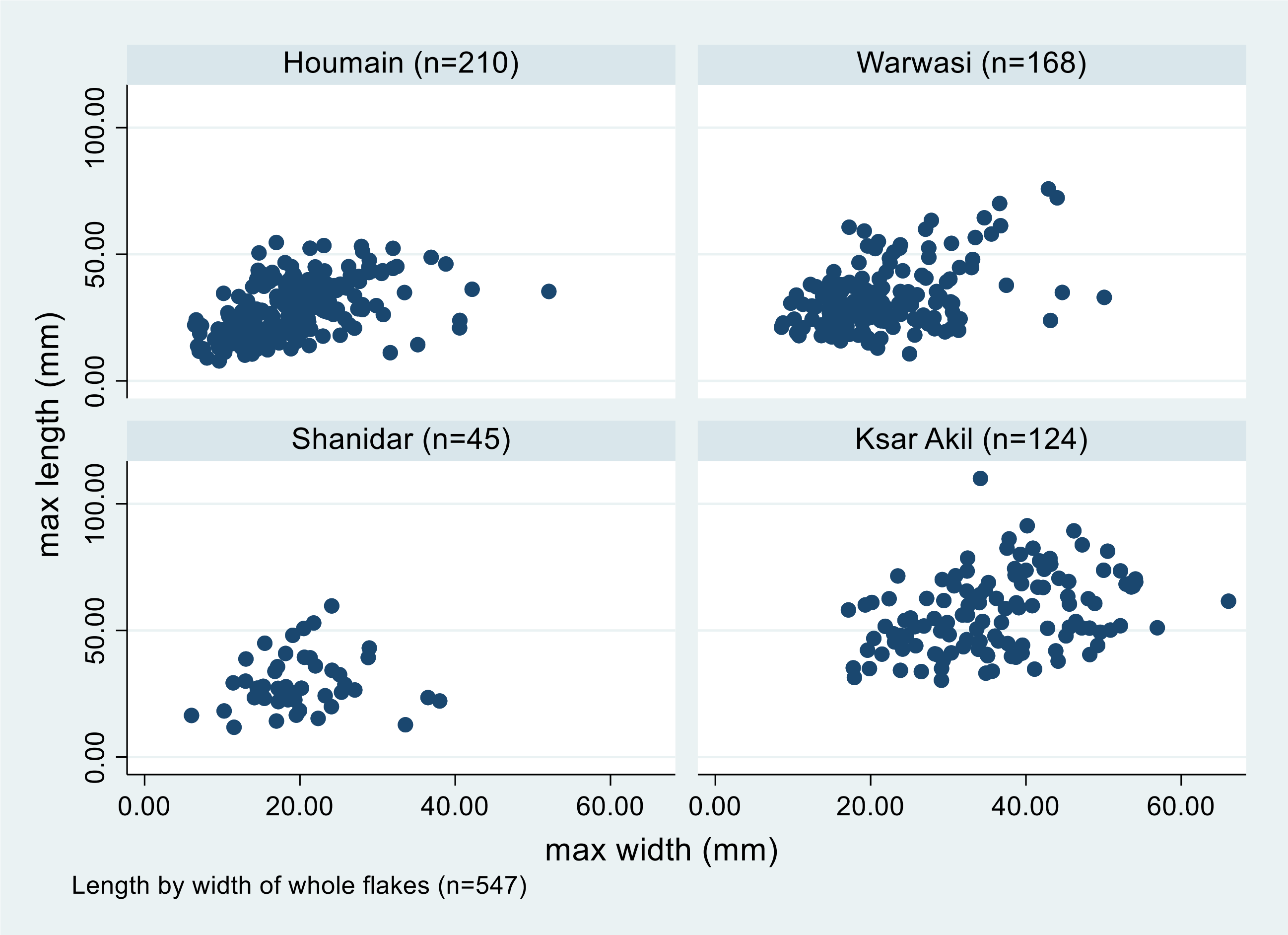

Figure 83 - Length/Width of whole flakes for all sites

Assemblage	Max length mean	Max width mean	Mean surface area (length x width)	N
Houmian	27.8	19.2	572.7	210
Warwasi	32.5	21.7	743.2	168
Shanidar	29.4	20.2	600.5	45
Ksar Akil	56.7	36.3	2113.9	124

Table 385 - Mean Length, Mean Width, and Mean Surface Area of whole flakes for all sites

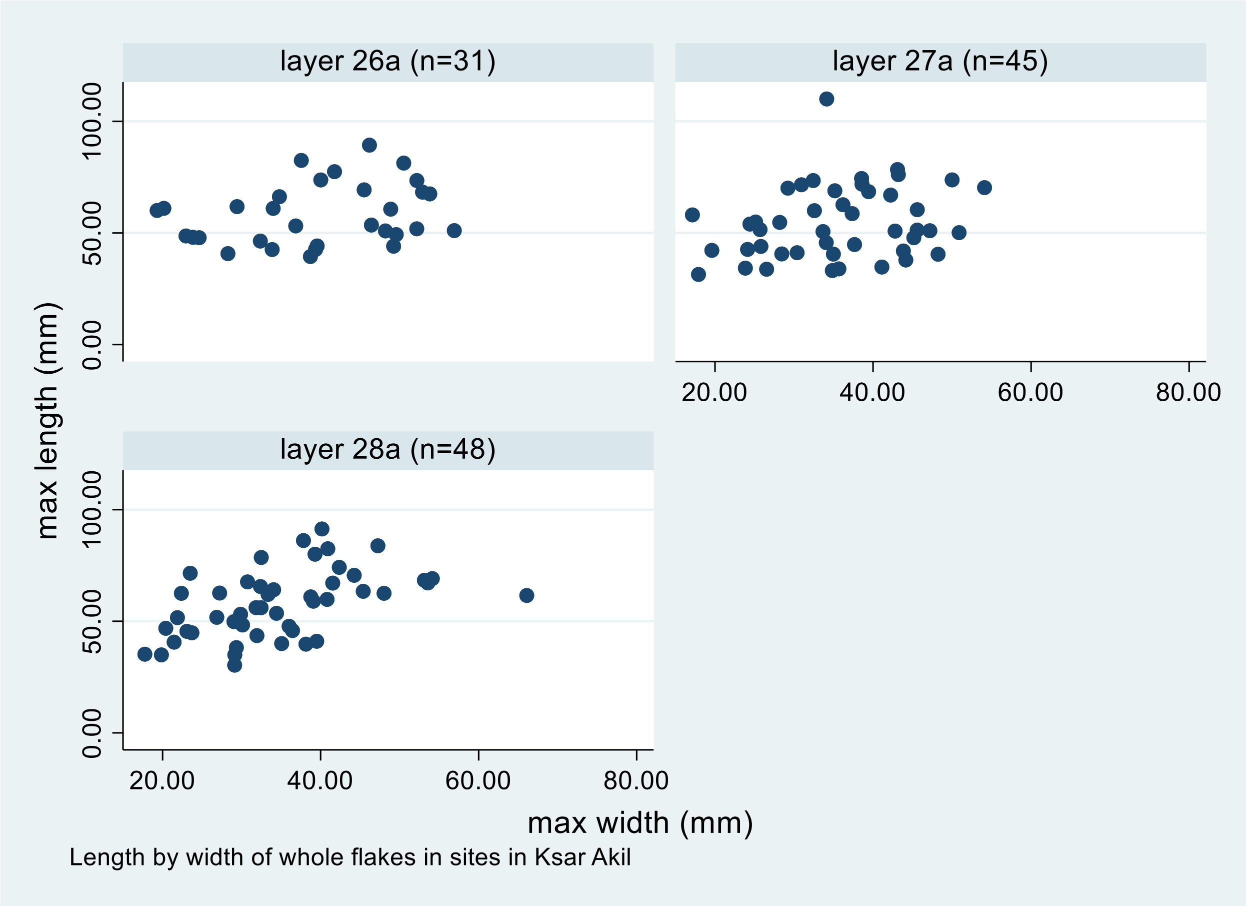

Figure 84 - Length/Width of whole flakes: Ksar Akil layers 28A, 27A, and 26A

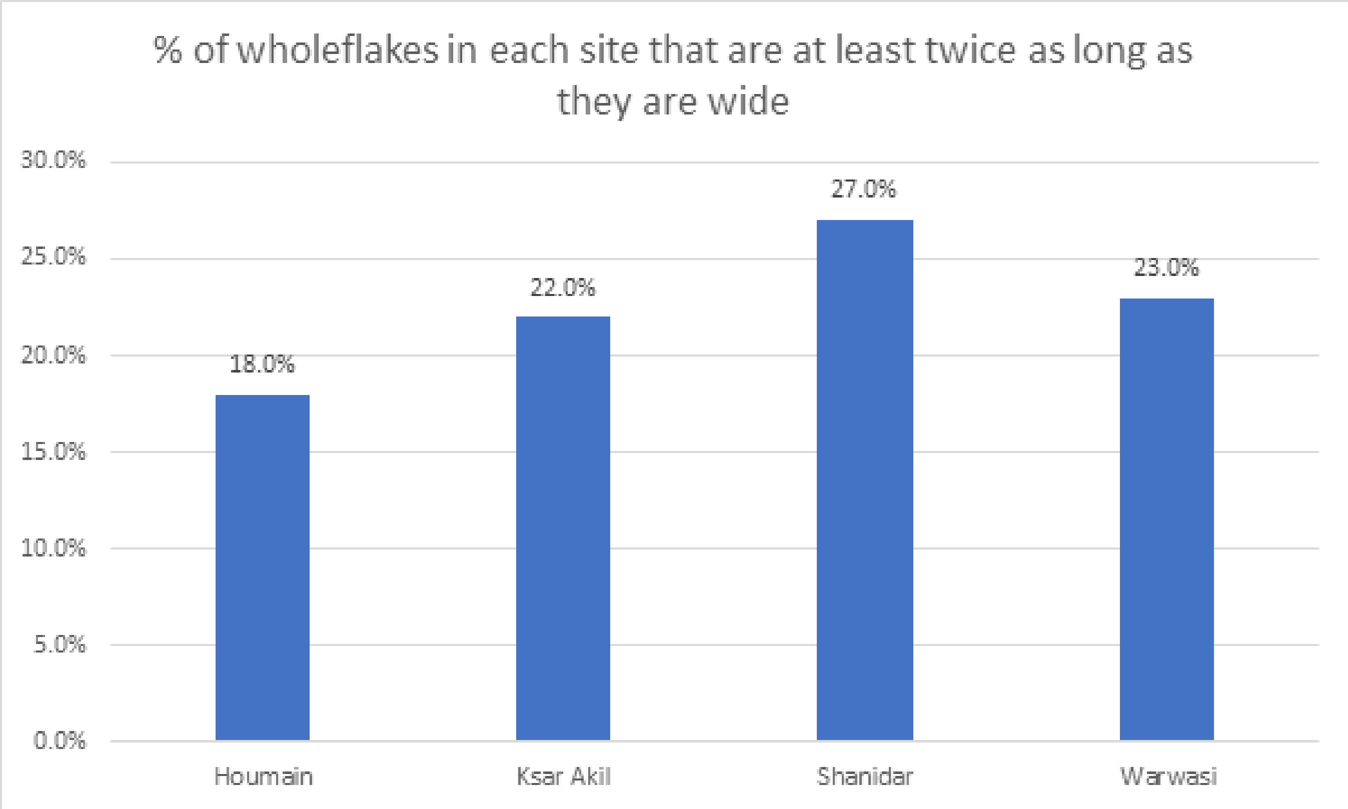

Figure 85 - Laminar appearance of whole flakes for all sites

9.3.1.2 Laminar appearance of whole flakes for all sites

Dibble (1991: 252) talked about the laminar appearance of the Zagros Mousterian debitage, while Shea (2013: 112) categorises it as "*relatively short and non-laminar*". While these two positions, whilst clear opposites, to some extent can be said to be subjective without qualification, the data presented in Figure 85 clearly shows that regardless of whether one would prefer the label of "laminar appearance" or "relatively short and non-laminar", there is no way of neglecting the fact that the Ksar Akil assemblages have very similar distributions of length/width ratios to the Zagros Mousterian assemblages (one-way ANOVA, p=0.23, no significant difference between groups). Therefore, the result of this test is that neither of these two statements, on their own, can be used to describe Zagros Mousterian debitage in general.

9.3.1.3 Cortex retention on dorsal surface of flakes

When comparing cortex retention on the dorsal surface of flakes, the difference observable when contrasting Houmian with Warwasi and Shanidar is quite distinct (Figure 86). While only slightly more than half of the Houmian sample is completely decorticated, those numbers are drastically higher for the latter two. Ksar Akil sits exactly in the middle between Houmian and Shanidar with two thirds of its assemblage completely decorticated.

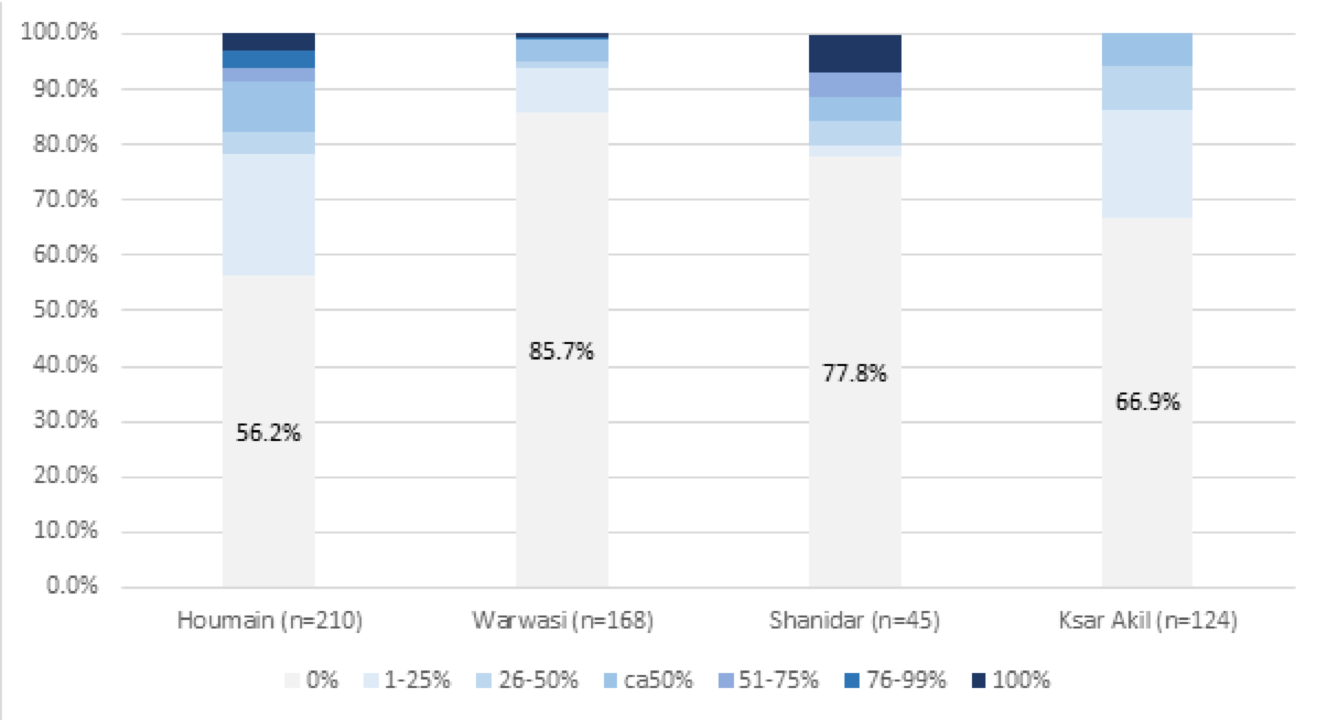

Figure 86 - Dorsal cortex on whole flakes for all sites

9.3.2 Techno-typological affinities associated with the Zagros Mousterian: Retouch

The Zagros Mousterian is claimed to be distinguished by extensive retouch, compared to the Levantine Mousterian, with a relative abundance of pointed and heavily retouched tools.

9.3.2.1 Ratio of Retouch Area Length to Length of Margins

Measuring the amount of retouch (as length in mm along a flake's inverse circumference) on each retouched flake, in each of my sample site assemblages, has made it possible to compare the mean amount of retouch as a ratio. This ratio can then be used as a proxy for retouch intensity in a comparison of retouched flakes between sites.

In figures 87 and 88 the Length of Margins (total inverse circumference) is compared to Retouch Area Length (total combined length of retouch). The general trend visible for the three Zagros sites is that of a lower mean for the ratio of Length of Margins to Retouch Area Length compared to that of Ksar Akil. However, looking more closely, it appears that while the retouched samples from Warwasi and Shanidar have very similar means, the Shanidar sample is much more consistent, i.e. varies less, than that of Warwasi. This means that the size of flakes (as a measure of inverse circumference) and the amount of retouch displayed (on that circumference) is closer in size. In other words, the flakes from Shanidar are more similar in size and more intensely retouched than those from the Warwasi sample. Turning to the Houmian sample, this assemblage has a noticeably higher mean than the former two Zagros samples. This corresponds to noticeably less retouch per retouched flake. The Levantine sample from Ksar Akil demonstrates both the greatest distribution in flake size and the smallest total amount of retouch to flake inverse circumference. Consequently, what is revealed is that both Houmian and Ksar Akil have greater variability in distribution in the proportion of the tool that is retouched.

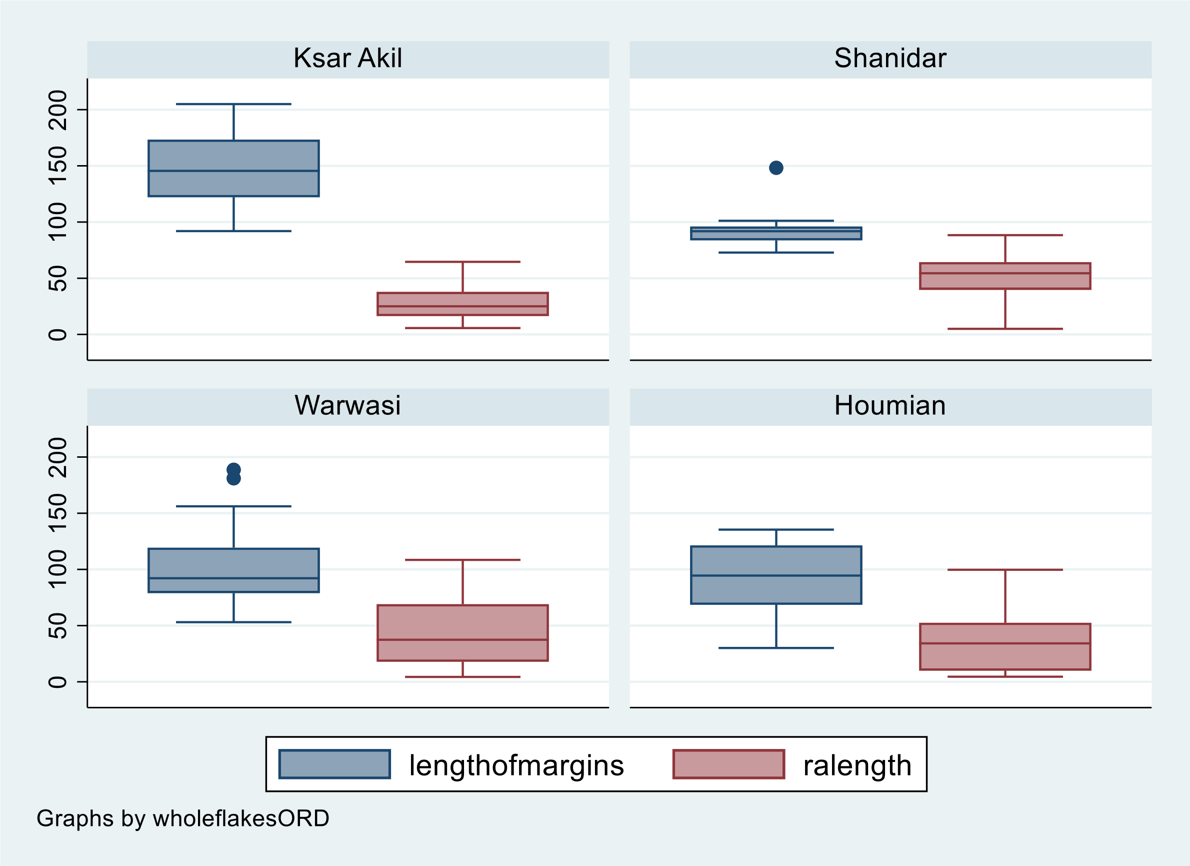

Figure 87 - Ratio of Retouch Area Length to Length of Margins

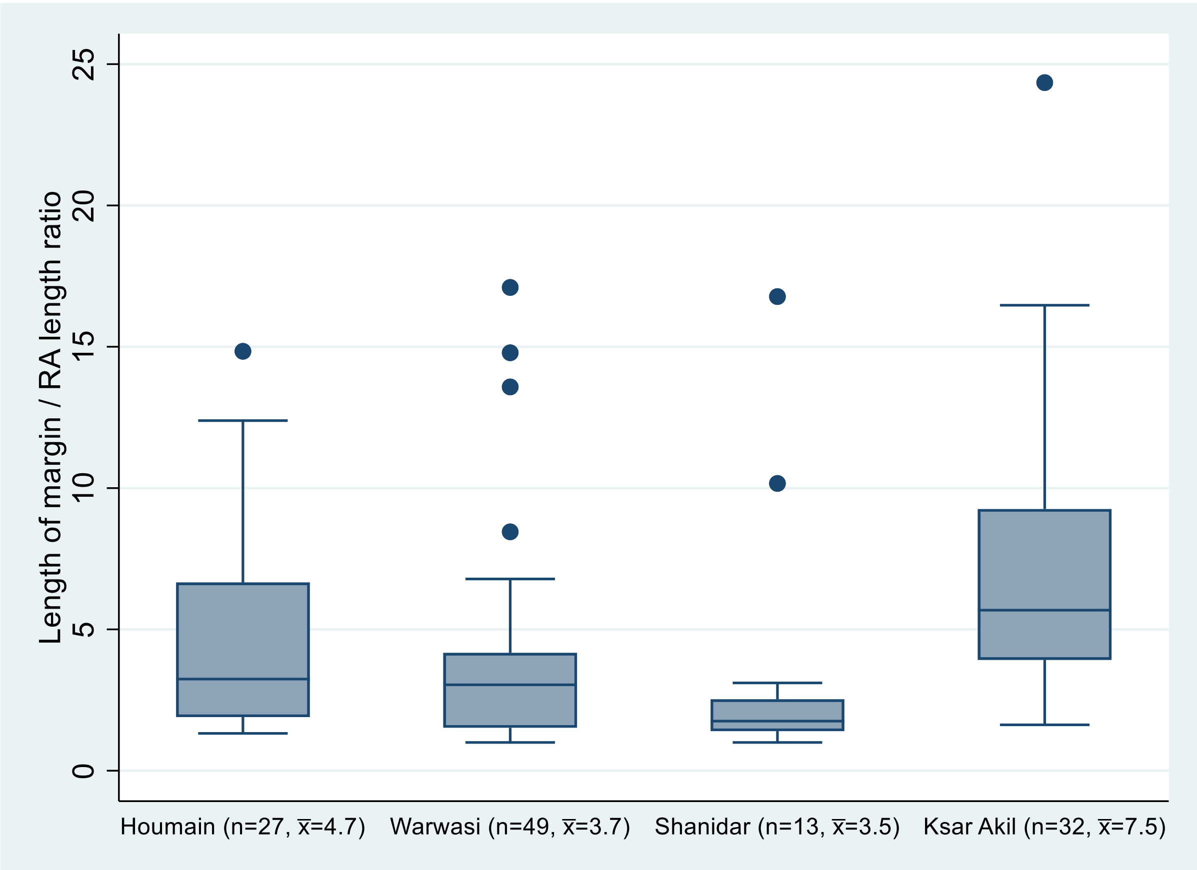

Figure 88 - *Ratio of Retouch Area Length to Length of Margins*

9.3.3 Retouched Flakes to Unretouched Flakes: Proportions

Figure 89 shows the percentage of retouched flakes to unretouched flakes by site assemblage. To get a true appreciation of strictly those proportions, unretouched tools and unretouched multi-tools are here counted as "unretouched flakes". Warwasi and Shanidar have very similar proportions of retouched flakes, with Houmian having only 1/3 in comparison. The assemblage from Ksar Akil sits exactly in the middle between the two former and the latter Zagros assemblages with regards to retouch. When looking at only whole flakes, there is no change to the Houmian and Ksar Akil assemblages, while the proportions of retouched flakes for both Warwasi and Shanidar drops with 5% (Figure 90).

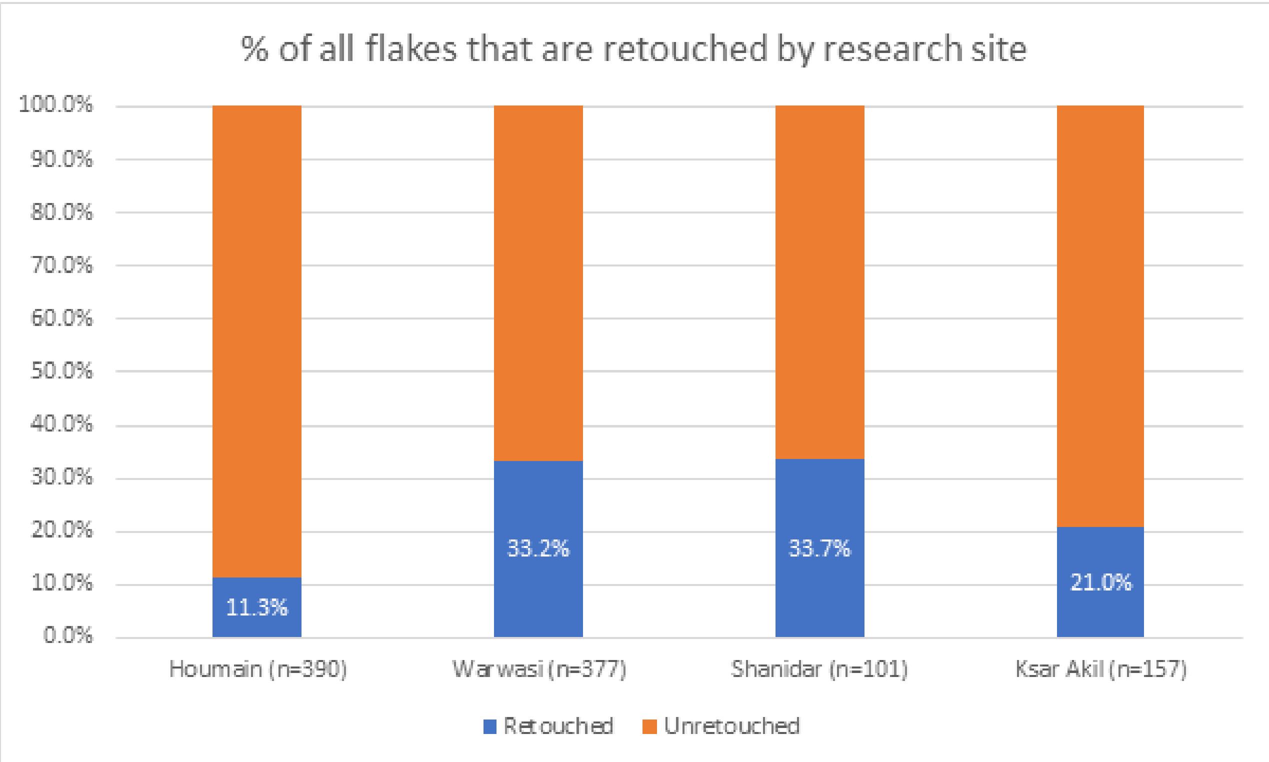

Figure 89 - Retouched to Unretouched flakes (whole and broken)

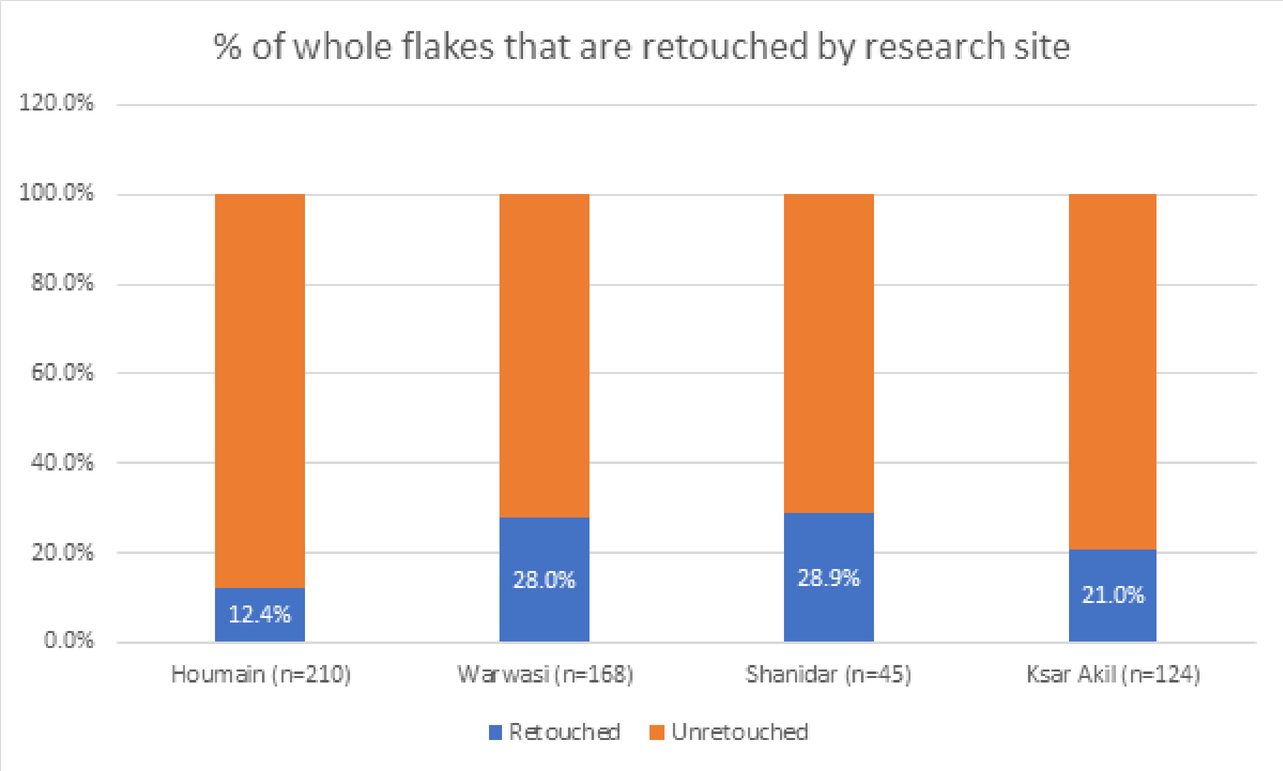

Figure 90 - Retouched to Unretouched flakes (whole)

9.3.4 Retouched Flakes to Unretouched Flakes: Proportion of Typologies

Figure 91 shows the proportion of typologies (i.e. different data classes) of retouched flakes to unretouched flakes. Unretouched tools and unretouched multi-tools are now counted together with their respective retouched equivalents. In this graph, Warwasi and Shanidar again display similar levels of retouched flakes, but this time the figures from Ksar Akil are quite identical, with only the typological proportions differing between the three sites. Though, even when breaking down those proportional differences of typological categories of retouched flakes, the two Zagros sites cannot readily be argued to display any clear coherence separating them from the Levantine one. Rather, the three individual assemblages could reasonably be attributed to either the Zagros or the Levantine Mousterian. This indistinctiveness is carried over, albeit with minor changes to the typological composition, when looking only at whole flakes (Figure 92). It is interesting to observe here that proportions of unretouched flakes rise with ca. 10% for both Shanidar and Warwasi, *as well as* Ksar Akil. In comparison, the typological distribution of Houmian is immediately very different both when examining the joint whole and broken-flake sample, and the whole-flake sample only. Unretouched flakes vastly dominate, and the amount of retouched flakes to tools are close to equal. This latter aspect matches Houmian with Ksar Akil who has an even 50/50 distribution of retouched flakes to tools when both whole and broken flakes are reviewed. This feature then suggests a commonality between these two sites. Conversely, when looking at whole flakes only, suddenly it is Houmian and Shanidar that strikes an accord, with very similar 50/50 levels of retouched flakes to tools.

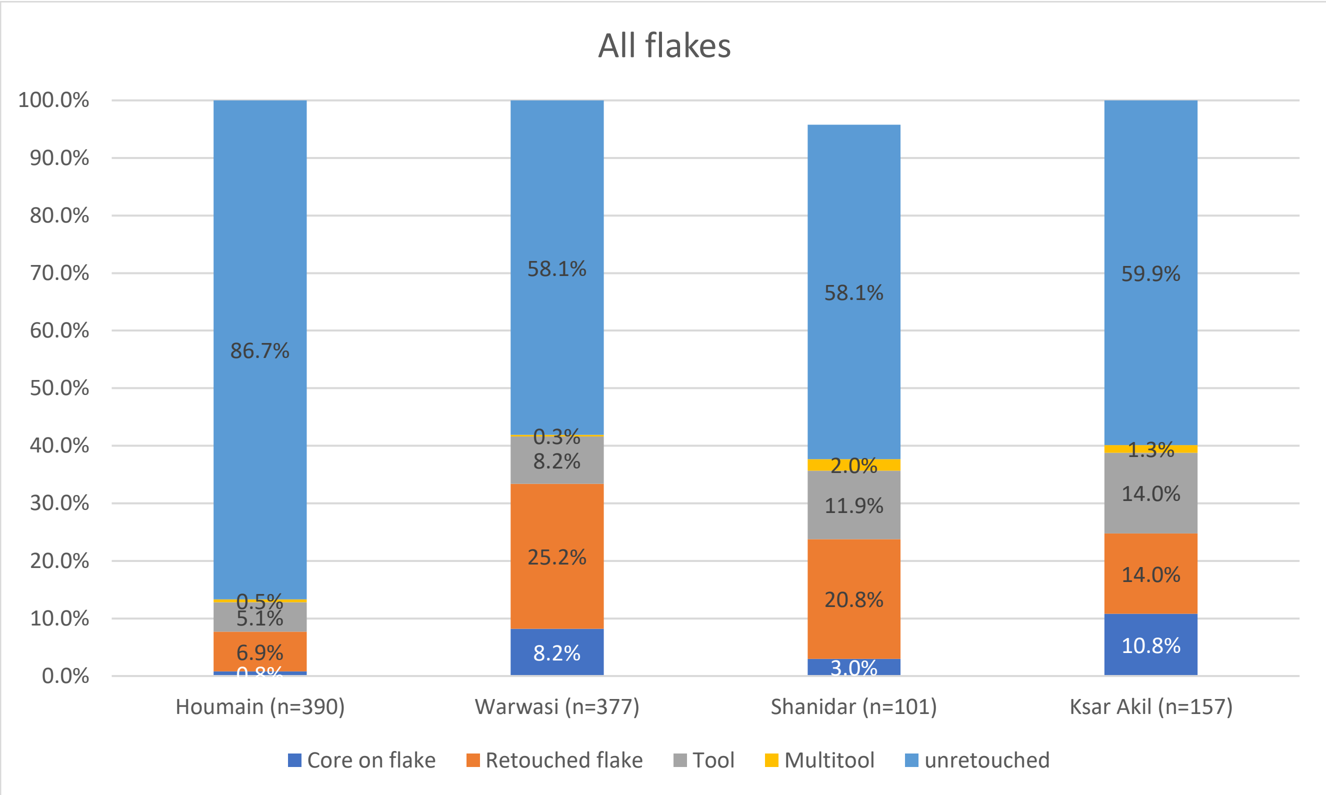

Figure 91 - Typology of retouched flakes to unretouched flakes (whole and broken): 'Proportion of typologies' of Retouched flakes to Unretouched flakes

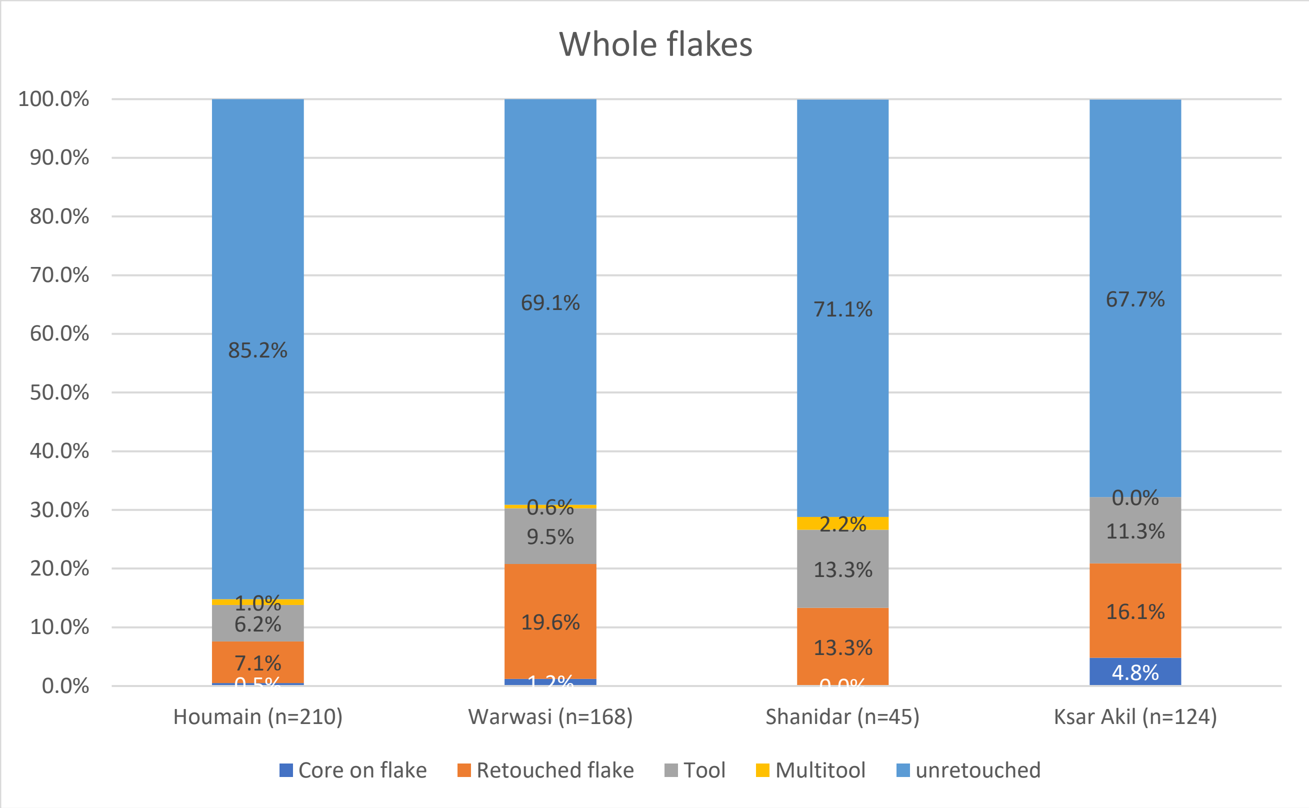

Figure 92 - Typology of retouched flakes to unretouched flakes (whole): 'Proportion of typologies' of Retouched flakes to Unretouched flakes

9.3.5 Retouched Flakes to Tools: Proportion of Typologies

Figure 93 takes a closer look at the proportion of typologies between retouched flakes and retouched tools (not including unretouched tools or unretouched multi-tools). All four assemblages have considerably larger quantities of retouched flakes compared to retouched tools and multi-tools. All four sites have broadly similar proportions (57.5%, 61.3%, 55.8%, 44%) of retouched flakes relative to the three other data class categories (i.e. core-on-flakes, retouched tools and retouched multi-tools). The only statistically significant difference was observed between Warwasi and Ksar Akil, with the proportion of retouched flakes significantly larger in the former, compared to in the latter (chi-square, $p<0.05$). When proportions for retouched flakes are compared only to retouched tools and retouched multi-tools, the proportions from Houmian and Shanidar are almost identical (61.4%, 61.6%); Ksar Akil is slightly higher at 66.7%, and Warwasi higher still at 76.6% (no differences between groups were found to be statistically significant, chi-square $p=0.13$).

Two further points of interest are the inter-site proportional composition of core-on-flakes, relative to retouched flakes and tools. The proportion of core-on-flakes in Ksar Akil (34%) was found to be significantly higher than that contained in any of the Zagros assemblages; which had significantly lower core-on-flake proportions of 6.4% in Houmian (chi-square, $p<0.01$), 9.3% in Shanidar (chi-square, $p<0.01$) and 20% in Warwasi (chi-square, $p<0.05$). Further, the proportions of core-on-flakes to retouched flakes and tools in the Warwasi assemblage was found to be significantly higher than that of Houmian (chi-square, $p<0.05$).

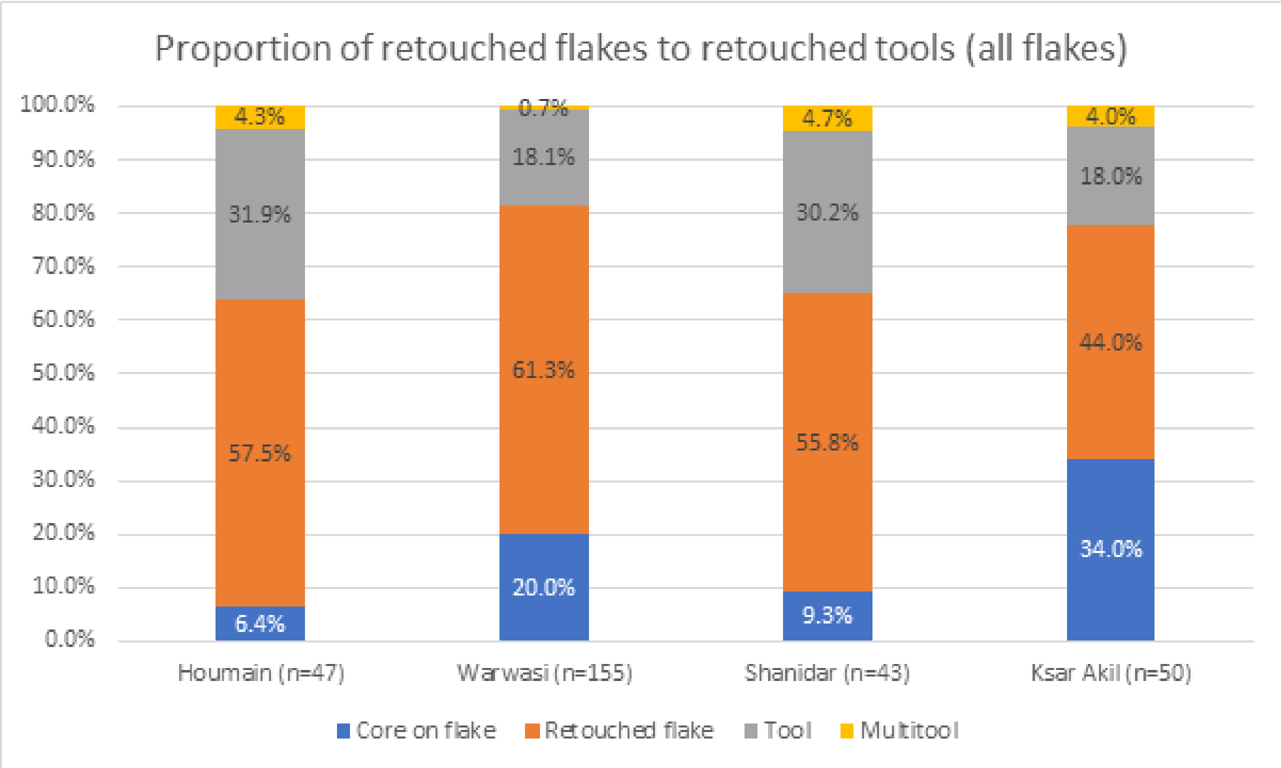

Figure 93 - Proportion of retouched flakes to retouched tools (whole and broken): 'Proportion of typologies' of Retouched flakes to tools

Looking at whole flakes only, considerable changes occur in the proportions of retouched flakes and tools within all sites except Houmian (Figure 94). At Warwasi, the amount of these two data class types increases notably. At Shanidar, one increase and one decrease substantially. At Ksar Akil, one stays the same while the other increase drastically. The fall in core-on-flakes in Figure 94 is explained by the fact that the technological actions involved in reducing this data class, typically would be expected to create "broken" pieces.

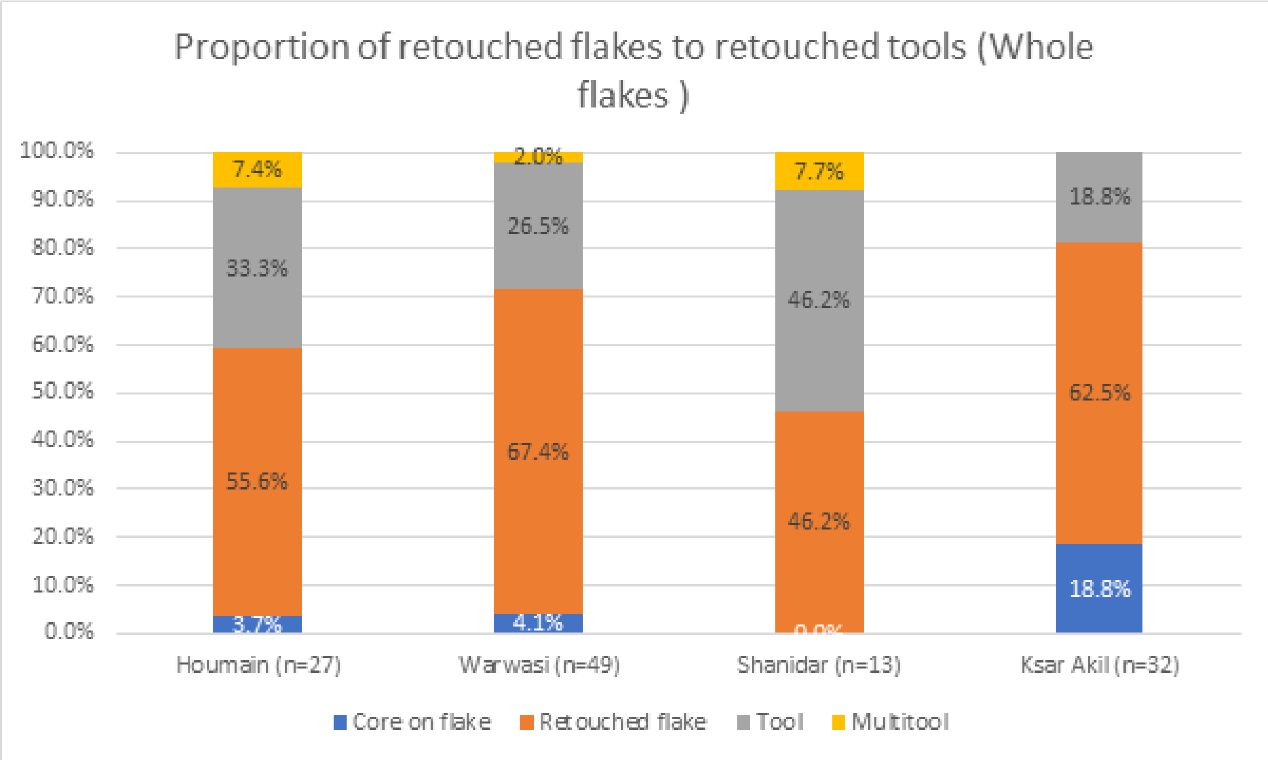

Figure 94 - Proportion of retouched flakes to retouched tools (whole): 'Proportion of typologies' of Retouched flakes to tools

9.3.6 Tool Types: Proportion of Typologies

Although the tool type sample sizes are quite small, some interesting trends nevertheless, tentatively, can be recognised between the four sites (Figure 95).

The category of Mousterian points can arguably be attributed, on typological grounds, to either the scrapers' group or the Levallois points' group, based on assumed functionality. While the deliberation on such functionality is beyond the scope of this thesis, for the purposes of this examination of tool types, I will group Mousterian points with scrapers, as the qualitative variables of retouch (e.g. position, location, distribution, shape, and especially extent and morphology; see Chapter 4) associated with this particular tool type, in my opinion, lends itself more persuasively for inclusion in the scrapers' group.

Scrapers: As such, Houmian, Warwasi, and Ksar Akil have proportions of scrapers equal to ca. 18%, 16%, and 12%, respectively, while Shanidar has a much higher proportion at ca 37%.

Burins: Houmian and Ksar Akil have equal, relatively low, proportions of burins, while Warwasi and Shanidar have equal, high, proportions of burins.

Notches: Notches have been identified in very small proportions, as part of multi-tools, at Houmian and Shanidar, but not on their own like at Ksar Akil.

Borers/Becs: Houmian and Warwasi have equal, relatively high, proportions of borers/becs. Shanidar and Ksar Akil have equal, relatively low, proportions of borers/becs

Levallois points: Ksar Akil has high, and Houmian relatively high, proportions of Levallois points. Warwasi has a low proportion, and Shanidar none.

It is my assumption that tool type variability, both within and between sites, are more variable, and susceptible to being distorted due to intra-site spatial patterning, than are core to flake variability (and core to core-on-flake variability). For this reason, I will not engage in any definitive behavioural inferences based on the above tool-type variability, but rather complement my techno-typological assessment with those findings.

Nevertheless, the overall trends from the sample assemblages for the four sites does outline some broad features, which could bespeak behavioural significance. As such, Houmian has elevated numbers for borers (36%) and Levallois Points (32%). Warwasi has elevated numbers for burins (50%) and borers (25%). Shanidar has elevated numbers for burins (50%) and scrapers (25% + 12.5% = 37.5%). Ksar Akil has elevated numbers for Levallois points (58%).

While one would have to be cautious in making any generalisations based on the analysis of tool-types, it is interesting that Houmian has such a relatively high amount of Levallois points. This would seem to suggest a techno-behavioural link between this Zagros site and Ksar Akil Level 28A. Ksar Akil Level 28A had a substantial proportion of Levallois points compared to levels 27A and 26A. The techno-behavioural link between Houmian and Ksar Akil is reflected throughout this comparative analysis.

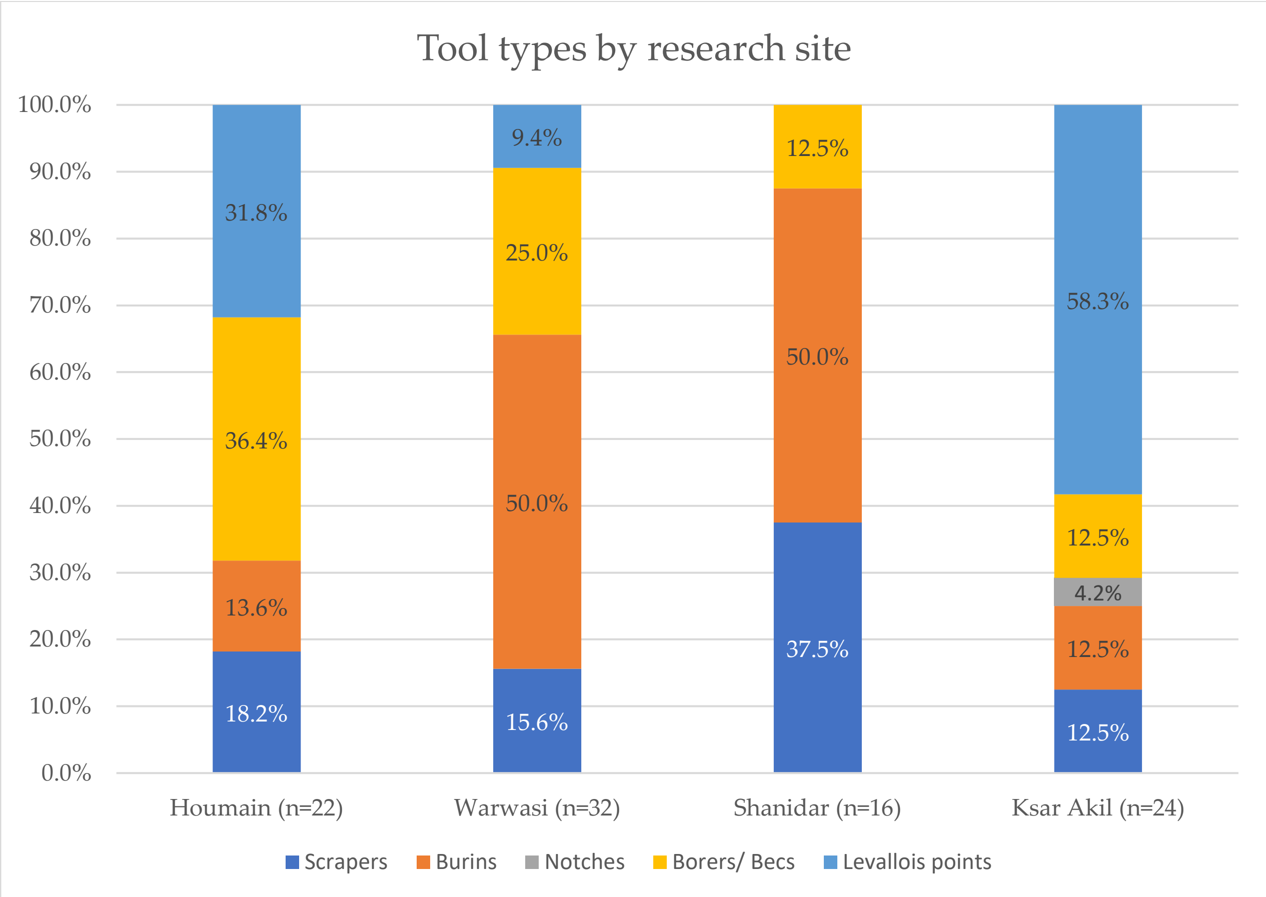

Figure 95 - Tool Types: Proportion of Typologies (whole and broken)

9.3.7 Pointed and heavily retouched tools

A famous feature of the Zagros Mousterian is the steeply retouched convergent (Mousterian) points. As mentioned in Chapter 6, I was not able to locate the part of the Shanidar assemblage known as the "pointed tools" (Solecki and Solecki 1993), which likely would have boosted the numbers for my Shanidar assemblage substantially. However, even with the material at hand, Shanidar clearly has the largest proportion of steeply retouched convergent tools (i.e. tools displaying invasive levels of stepped "Quina-type" retouch) (Figure 96). While it is perhaps unsurprising that this tool type is entirely absent at Ksar Akil – and possibly only half surprising that it is virtually absent at Houmian – that it is equally virtually absent at Warwasi is surprising indeed. Two features stand out: a remarkable uniformity of inter-site proportions exists both when the groups of 'heavily retouched' and 'non- to slightly retouched' pointed flakes are combined, and when the group of 'non- to slightly retouched' pointed flakes are considered by themselves. Combined, Houmian, Shanidar, and Ksar Akil have 16.7%, 15.9%, and 17.8%, respectively. Warwasi has 11.1%. Without the heavily retouched segment, Warwasi and Shanidar have proportions of 10.6% and 10.9%, and Houmian and Ksar Akil that of 15.9% and 17.8%, respectively. Without the heavily retouched category included, it is again Warwasi and Shanidar on the one side, and Houmian and Ksar Akil on the other, who have similar figures.

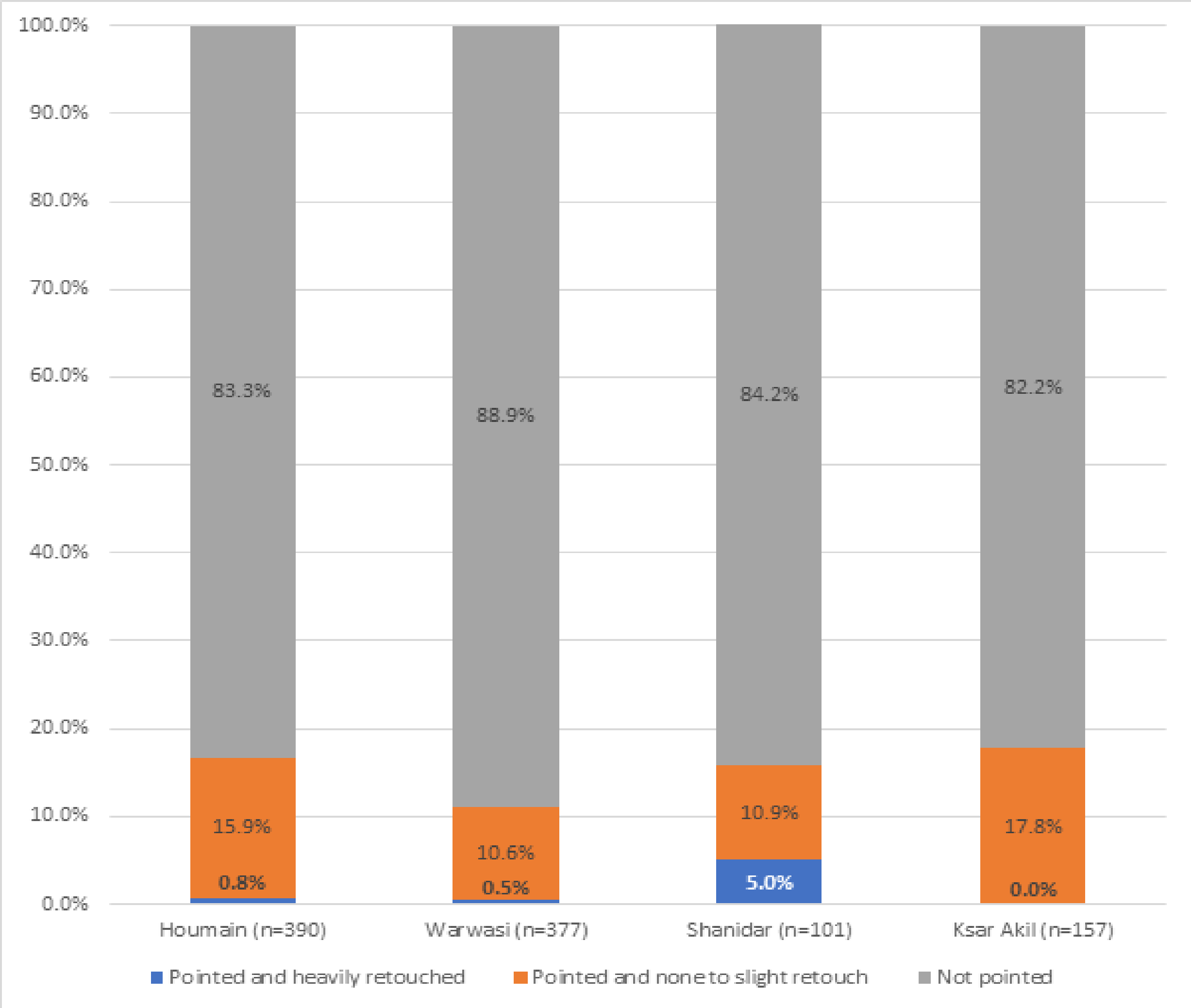

Figure 96 - Pointed and heavily retouched tools

When looking more broadly on the entire population of heavily retouched tools and flakes (both whole and broken) – not exclusively pointed tools – invasive and stepped retouch is clearly more prevalent at Shanidar and Warwasi than it is at Houmian and Ksar Akil (Figure 97). Within Ksar Akil, Layer 28a has elevated figures when compared to levels 26a and 27a (Figure 98).

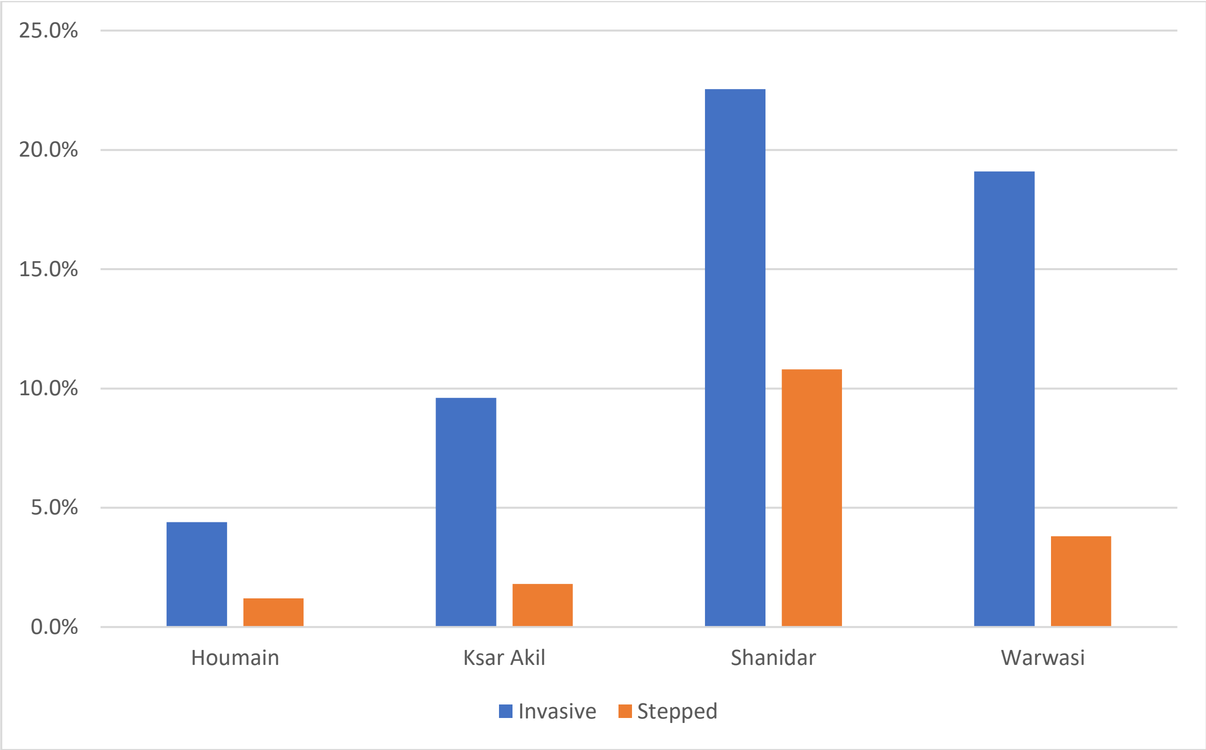

Figure 97 - Amount of ‘invasiveness of retouch’ and ‘stepped retouch’ in flakes for all sites (whole and broken flakes)

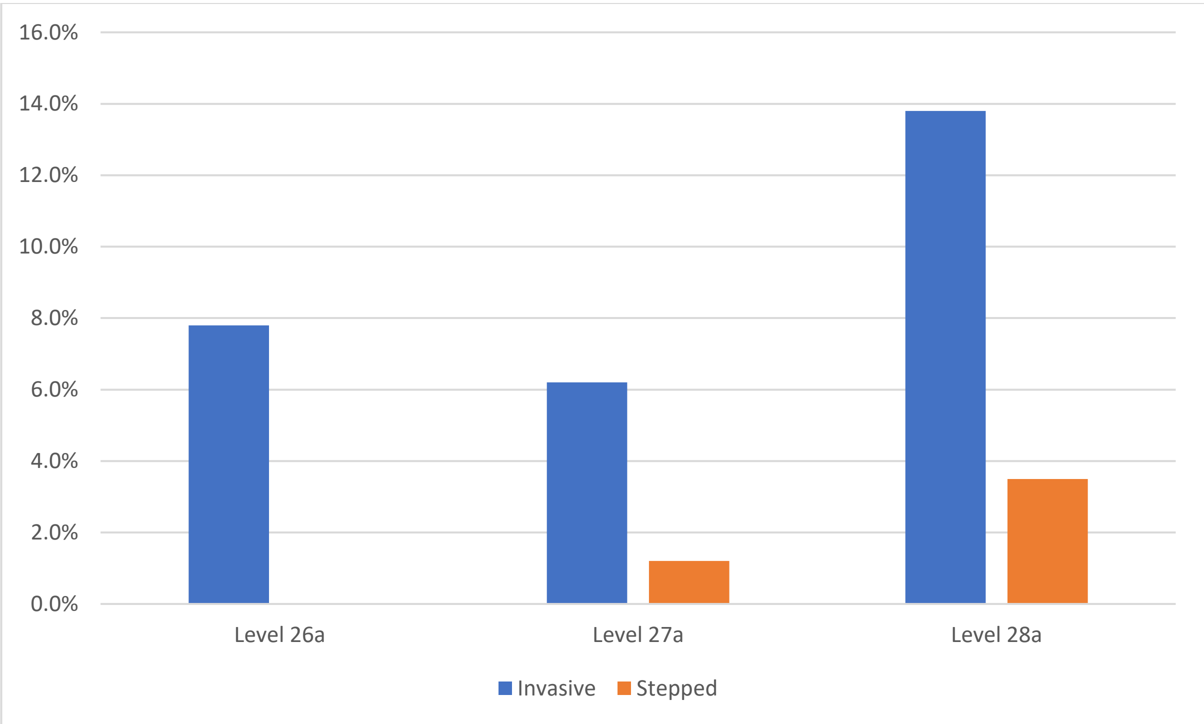

Figure 98 - Amount of ‘invasiveness of retouch’ and ‘stepped retouch’ (Ksar Akil levels). (whole and broken flakes)

9.3.8 Techno-typological affinities associated with the Zagros Mousterian: Cores

The Zagros Mousterian techno-complex is claimed to revolve around a particular set of core reduction technologies, including a focus on truncated-faceted pieces/cores-on-flakes, as well as discoidal core exploitation. Skinner (1965) originally, erroneously, declared that Levallois technique were not part of the Zagros Mousterian -a point Dibble (1984a, b) later corrected by providing evidence for Levallois technology in the Zagros through re-examination of the Bisitun material, and later further verified when publishing the Warwasi collection (Dibble and Holdaway 1993). Nevertheless, Lindly (1997:140-141:) insists identification of Levallois cores (i.e. identification of Levallois reduction through the analysis of cores) are too complex for the Zagros, and therefore at risk of causing inter-analyst variation and confusion. His solution to this perceived issue is to completely ignore the concept of Levallois and instead categorise cores based on knapping patterns. He continues to create two categories of cores: "uni- and bi-directional" and "centripetal" cores. His rationale for doing so is based on his theory that raw material conservation due to raw material scarcity creates situations where cores become continually smaller, volumetrically, the higher up in the mountains hominin foragers move. This progression of loss of core-mass, he argues, imposes physical constraints on knapping patterns, compelling the knapper to eventually switch from (an allegedly preferred) uni-directional and/or bi-directional mode of reduction to centripetal, or "radial", mode of reduction. Lindly sees this relationship between the switch of utilisation from "uni- and bi-directional" core reduction to "centripetal" core reduction, as a hall-mark of the Zagros Mousterian. This will be examined below.

9.3.8.1 Core-on-Flakes and Truncated-Facetted Pieces to Cores

The techno-behavioural system alleged by Lindly (1997) to be underlying the "Summer Adaptation Hypothesis", and thus making up a fundamental part of the Zagros Mousterian techno-complex, holds as one of its main tenets a shift from the exploitation of uni- and bi-directionally flaked cores to centripetal cores and "truncated-facetted cores" (core-on-flakes/truncated-facetted pieces) from lowland sites to highland sites. In this thesis, “truncated-facetted cores” have been realised as flakes rather than cores, and further divided between core-on-flakes and truncated-facetted pieces. Both are considered flakes modified and used as cores. However, they are distinguished here as two slightly separate categories of the same technological entity. Core-on-flakes are simply flakes which have had one or more flakes detached from either ventral or dorsal surface following their own initial detachment. Detachments made from core-on-flakes have not been released from a pre-fabricated platform. Truncated-facetted pieces are differentiated from the former, by having a “platform” created from where one or more flakes subsequently have been detached. The “platform” is a truncation or otherwise preparation to facilitate the detachment of a flake.

This part of Lindly’s system seems to be well substantiated at Warwasi, where just over 2/3 of the flake producing entities are flake-blanks, rather than core-blanks (Figure 99). It is more difficult to say something instructive about the signal at Shanidar, as only 6 pieces are available. Due to the very low amount of cores available to me within the Smithsonian collection, it is not possible to get a realistic appreciation of the ratio of core-on-flakes and truncated-facetted pieces to formal cores. It is my assumption that likely most of the core assemblage seemingly is held in the collection in Baghdad (as mentioned in Chapter 6). This is possibly due to research question preferences of the 1950s, where retouched tools were considered more valuable in constructing culture-historical narratives. While this distortion is skewing the Smithsonian assemblage composition ratio of cores to flakes, there is no reason to suspect that this affects the original quantity of modified flakes like core-on-flakes and truncated-facetted pieces, as these parts of collections would have been more ardently curated, and therefore more likely is a reflection of the original levels of distribution. In that view, while the ratio of core-on-flakes and truncated-facetted pieces to cores shown here cannot be said to offer a real insight into the original proportions of the different typological entities, it does illustrate the very low amount of core-on-flakes and truncated-facetted pieces distributed within Layer D4. Conversely, with Houmian having a much more secure excavational history, the distribution of core-on-flakes to cores must be assumed to be very reliable. Including the fact that no truncated-facetted pieces are recorded from this Zagros site. These proportions are quite similar to those of Ksar Akil, although the latter site shows evidence for both core-on-flakes and truncated-facetted pieces. In Figure 100, the three levels are broken down individually. From that we see that it is within the older sample Level 28A, from where most of the core-on-flakes and truncated-facetted pieces derives, making up almost 50% of the flake producing core blanks. This proportion is much lower in the following Level 27A, and entirely absent in the youngest Level 26A.

What Ksar Akil shows us in these three levels is insight into changing techno-behavioural strategies. In this regard, Ksar Akil Level 28A is techno-typologically more like Warwasi, where flake blanks used as cores certainly can be confirmed to be extensive, while Ksar Akil Level 27A resembles Houmian in having in common a larger dependence on nodule cores.

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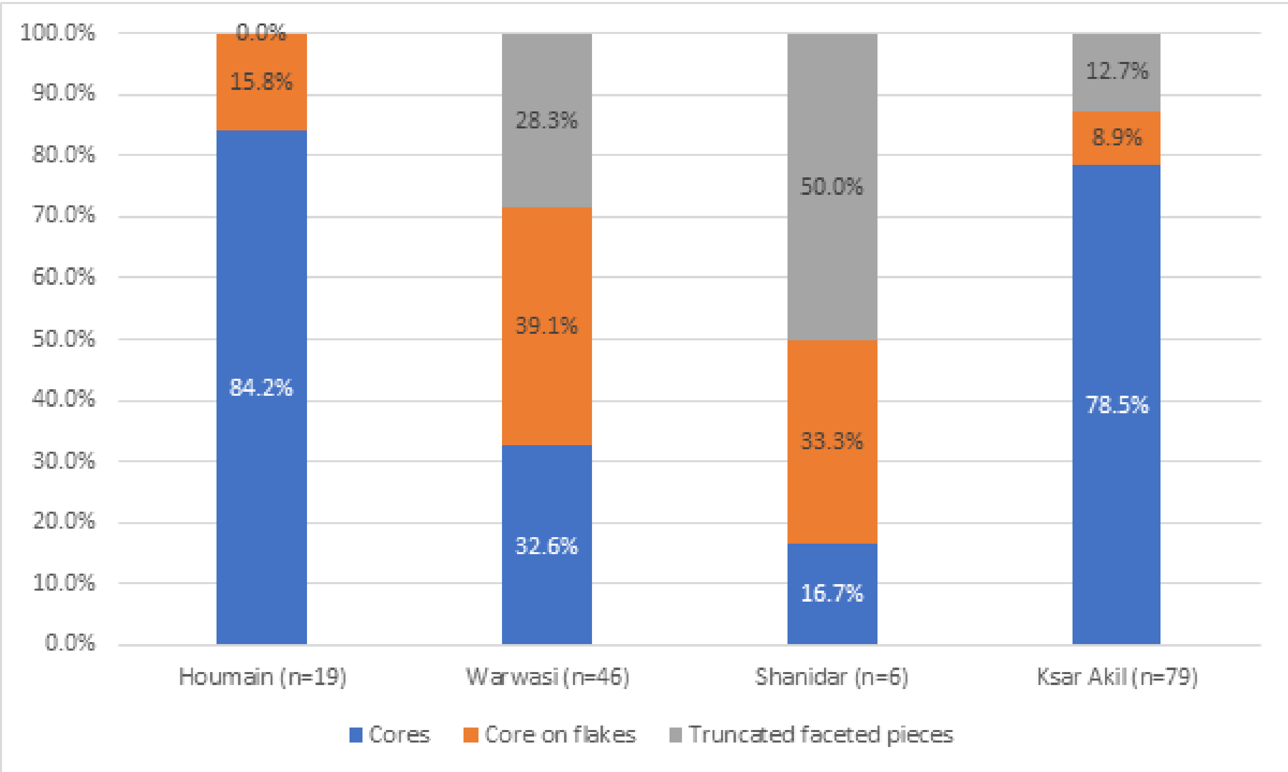

Figure 99 – Cores, core-on-flakes, and truncated-faceted pieces: all sites

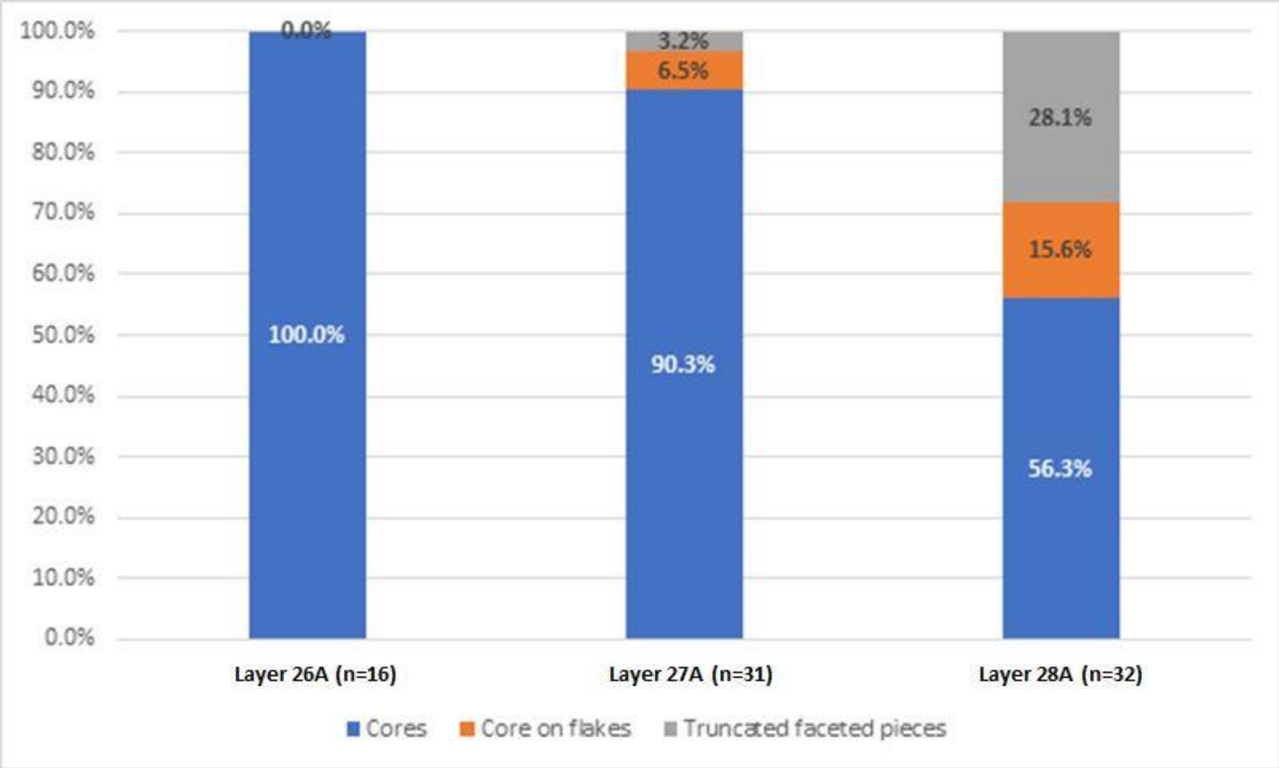

Figure 100 - Cores, core-on-flakes, and truncated-faceted pieces: Ksar Akil

9.3.8.2 Discoidal cores and discoidal knapping

Examining the claims of Skinner (1965:196) and Lindly (1997:16) of the presence of discoidal core reduction within the Zagros Mousterian, Figure 101 takes a look at proportions of fully discoidal cores compared to cores not techno-typologically discoidal, but dominated by alternate/discoidal knapping patterns (see Chapter 4), contrasted with cores of separate techno-typologies. Even with a low sample of cores for the combined Layer WWXX from Warwasi, no techno-typologically discoidal cores were found (half the cores are however defined as Levallois, see Chapter 7). One core is described as having an overall discoidal flaking pattern, which usually results from alternate knapping (see Chapter 4). As mentioned earlier, the core sample from Shanidar is very small, and as such cannot be expected to contribute much in the way of interpretation. One of three cores, however, is identified as being discoidal. Two and three of the cores from Houmian are discoidal and alternately knapped, respectively, which constitutes about 1/3 of the core sample from Layer 2a. Ksar Akil shows proportions of both discoidal and alternate knapping.

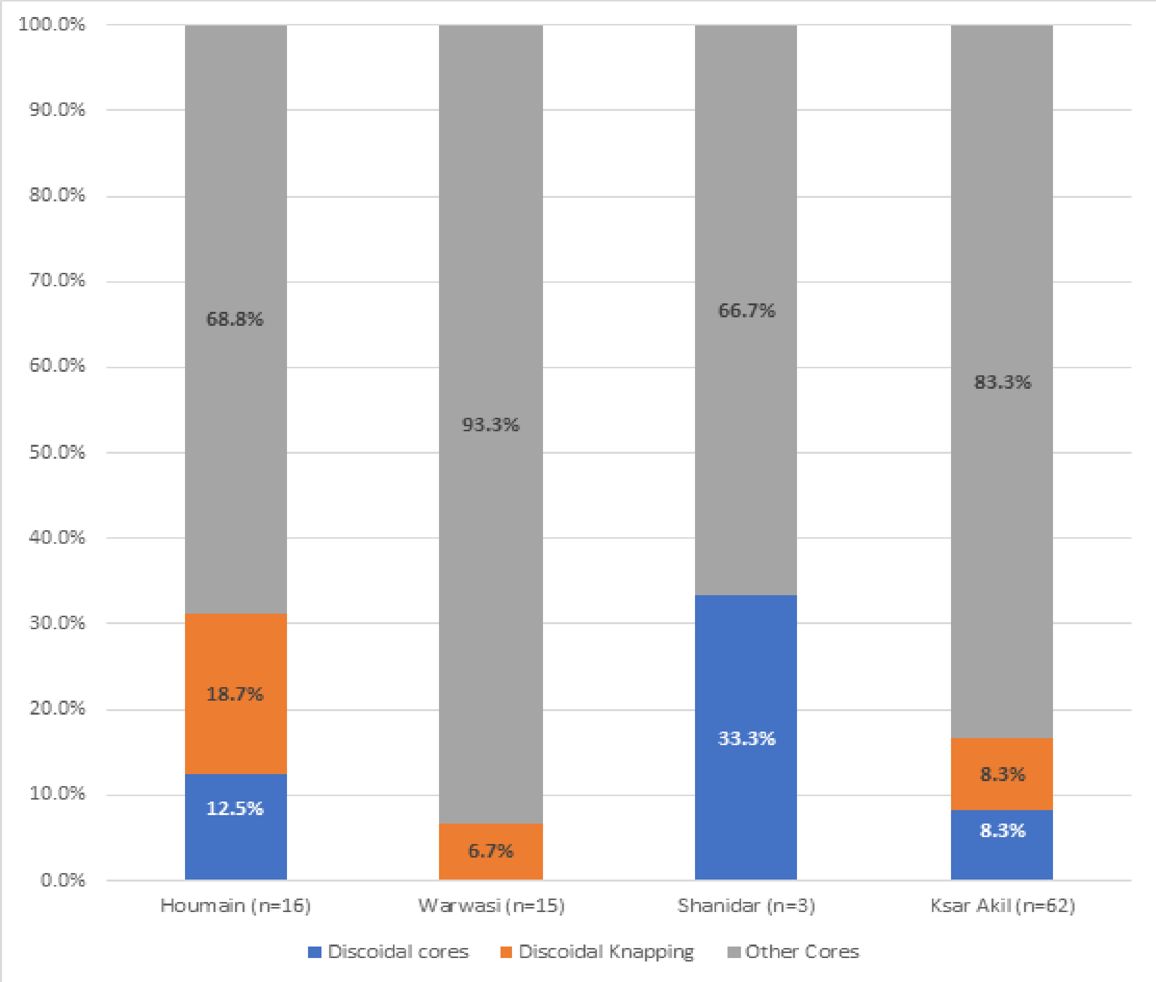

Figure 101 - Discoidal cores, discoidal knapping, other cores

9.3.8.3 Uni- and Bi-directional cores vs. Centripetal cores

As mentioned above, part of the techno-behavioural system claimed to constitute the Zagros Mousterian techno-complex, is the constricted altitude-determined utilisation of what Lindly (1997: iv, 312, 315-316) refers to as "uni- and bi-directional cores" and "centripetal cores". The former are alleged to be found more frequently in earlier parts of the Zagros land-use strategy, corresponding to lower-altitude locales. The latter are claimed to be found more frequently in the later stages of land-use strategy, i.e. at higher elevations:

"*Cores were reduced using longitudinal flaking at first and then the technology switched to centripetal flaking to extend the use-life of the core. If larger flakes were available, they were used as truncated/faceted cores*" (Lindly (1997: 315-316).

Due to perceived confusion about the technological specificities of the Levallois reduction strategy, Lindly (1997: 140-141), chooses to differentiate between "uni- and bi-directional cores" (i.e. uni- and bi-directionally exploited cores) and "centripetal cores" (i.e. centripetally exploited cores), and by doing so contends to avoid the problem of dealing with inter-observer subjectiveness related to the definition and interpretation of Levallois technique (e.g. Dibble and Bar-Yosef 1995), i.e. whether a core is Levallois or not. While I appreciate the way of framing the ontological approach in a non-typological (but specifically technological) structure, it is my opinion that discarding this inherently *techno-typological* and *techno-behavioural* phenomenon, that is Levallois, is problematic, as much behavioural information is lost in this conflation as is gained by a strict technological organisation.

In figures 102 and 103, and looking first at the lower of the three Zagros sites, Shanidar (albeit with only three cores) have only centripetal cores. At a higher elevation, Warwasi have about an even split between uni- and bi-directional cores and centripetal cores. Finally, at the highest elevation, Houmian show an almost exclusive emphasis on centripetal core exploitation. While the evidence from Shanidar is possibly not entirely reliable due to the low sample size, the fact that centripetal reduction is present cannot be denied. The evidence from Warwasi and Houmian, however, does seem to corroborate Lindly's model. Still, if the premise is that "centripetal" core exploitation is a proxy for raw material conservation (and conservation again a proxy for raw material constraints), then the information from Ksar Akil is confounding. With about an equal amount of uni-and bi-directional cores to centripetal cores it is difficult to explain the reason for the implied conservation of raw material, within an environment where raw material supposedly is abundant.

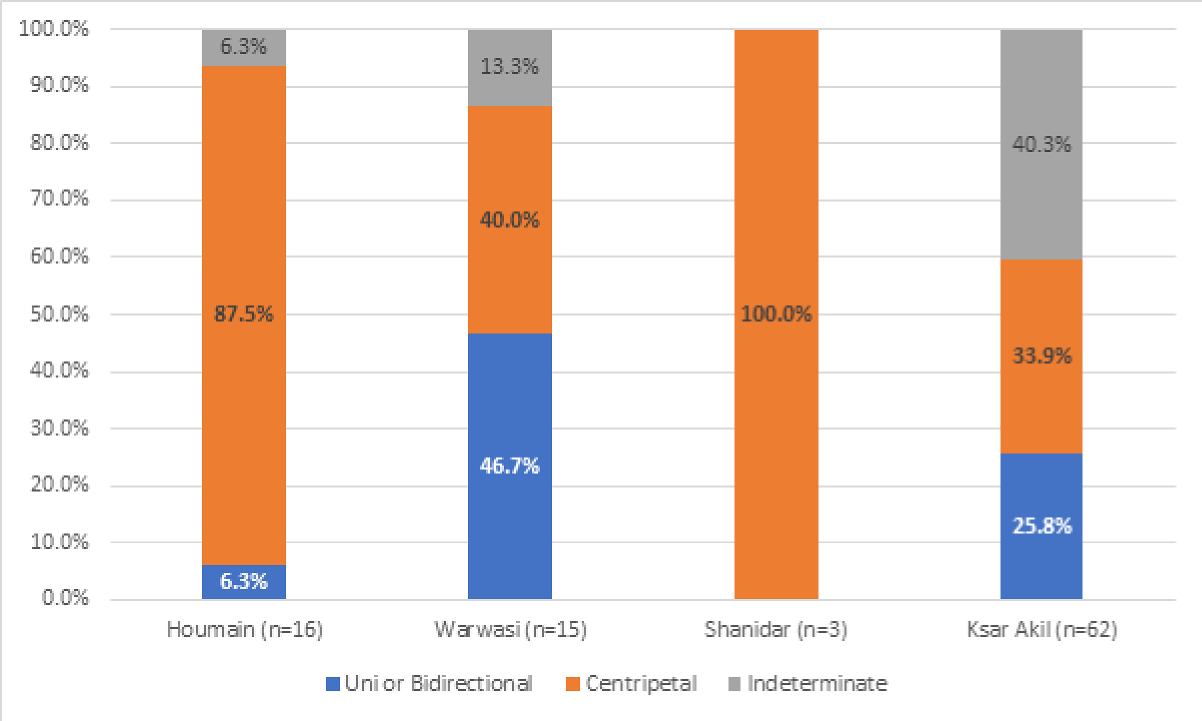

Figure 102 - Uni- and Bi-directional cores to Centripetal cores, including indeterminate cores

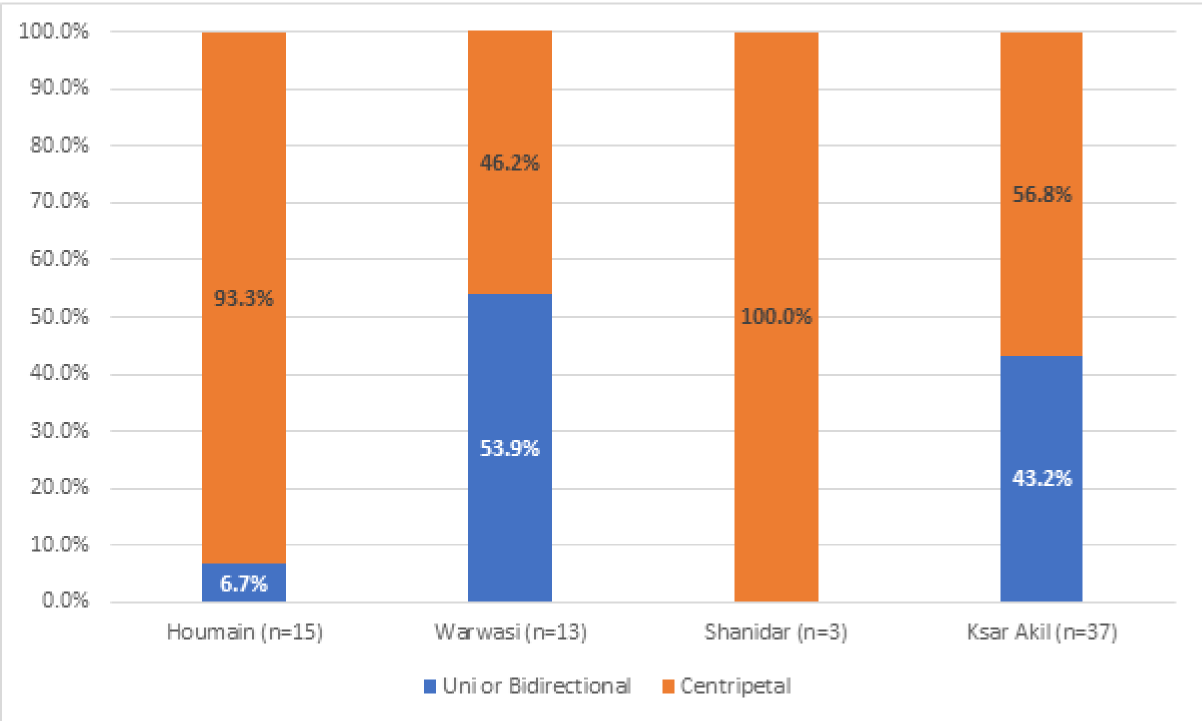

Figure 103 - Uni- and Bi-directional cores to Centripetal cores

9.4 Potential causes of observed variability in the lithic assemblages

The above comparative analysis of the lithic assemblages primarily dealt with observed variability on technological grounds, and its significance for the Summer Adaptation Hypothesis. By looking at potential causes of observed variability on functional grounds through tool-type typology, in tandem with published faunal data from the sites involved, some behavioural inferences can be drawn.

As mentioned above, any definitive behavioural inferences based on the tool-type variability presented here, would be premature, since neither chronostratigraphy nor related proxy data such as secure climatic or faunal data is at hand. As such, the below comments on functional variability amongst the three sites should serve only as possible avenues for future investigation.

Shanidar

Acknowledging the biased tool-type sample for this study, only the most tentative suggestions should be made here. The high proportion of scrapers and burins, as well as the presence of borers, although of low proportion, could be argued to relate to the evidence for the focused hunting of wild goat (see Chapter 2). In that respect it is highly surprising that no Levallois points were included in the assemblage, although their exclusion could be attributed a behavioural explanation. Levallois points could have been discarded in the landscape, or alternatively, if they were returned to the site broken, re-cycled into another tool. A modern explanation for the absence could be the small sample size of the collection.

While the prevalence of tortoise cannot presently be related to the lithic toolkit in a behavioural way, the fact that both wild goat and tortoise are frequent in all altitudes, arguably means altitude cannot be said to be the primary reason for occupying Shanidar. The implication for this would be that the specific tool-kit found at Shanidar cannot be said to be geared to specific 'high-altitude' hunting. A further, tentative, extrapolation is the suggestion that indications for non-summer-season site-use in the subsequent Baradostian period could be used as an argument for Mousterian site-use in similar non-summer parts of the year. The evidence from the Shanidar Baradostian of a caprid foetus from early spring, indicates human presence at Shanidar at this time of year (Marjolein Bosch, pers. comm.).

Warwasi

The Warwasi tool-kit included scarpers, burins and borers, but, like Shanidar stands out with the low proportion of Levallois points. With hunting focused on onager, the likely more open landscape around Warwasi would have precluded ambush hunting, which was presumed to have been practiced on the steep slopes around Shanidar. Levallois points likely would have furnished the main hunting weapons, and, as with Shanidar, their paucity in the record might be due to their function outside the occupational space. In contrast, tools associated with secondary processing like scrapers, burins, and borers, possibly are better represented due to their assumed primary function at the site, and the suggested longer use-life of these tools compared to Levallois points (see Chapter 2).

Houmian

As has been presented in the above comparative analysis, the Houmian lithic assemblage does not adequately resemble the assemblages from Warwasi and Shanidar, neither techno-typologically (size and typology of lithics) nor techno-behaviourally (as a part of Lindly's (1997) system, being a site located at a high altitude). The amount of Levallois points in the Houmian assemblage fits well with the near-exclusive faunal material of goat/sheep. Scrapers, burins, and borers are also represented.

9.5 Refutation of the "Summer Adaptation Hypothesis": the techno-typological evidence

As has been demonstrated above, there are, on the one hand, too few differences between the techno-typological attributes represented by the Zagros Mousterian and the Levantine Mousterian, and, on the other hand, too much variability among the Zagros Mousterian site assemblages, to justify the maintaining of the conceptual framework of the Zagros

Mousterian techno-complex. While the claim of comparatively short flakes for the Zagros sites was found to be corroborated by the data, compared to Ksar Akil, other claims could not be corroborated.

As such, the claim of comparatively non-laminar debitage was not upheld by the data. Neither was the relative abundance of pointed and heavily retouched tools, while extensive retouch only to some extent was verified. Discoidal core preparation was present but not as such specific to the Zagros, and hence really cannot be said to hold any real significance either way. The focus on truncated-faceted pieces/cores-on-flakes was not systematically substantiated by the Zagros data, and found to be prolific in part of the Levantine site of Ksar Akil. This makes the assumption of truncated-faceted pieces/cores-on-flakes as a distinctive component of the alleged techno-behavioural system of the Zagros Mousterian problematic.

Taking the assemblages from Shanidar and Warwasi as alleged examples of the Zagros Mousterian, as asserted by Skinner (1965) and Lindly (1997), the figures recorded for Houmian represent an inconsistency to the claim of geographic coherence, while the figures recorded for Ksar Akil represent an inconsistency to the claim of regional techno-typological variability.

I will argue that my demonstration of the inherent inter-site variability of Mousterian Middle Palaeolithic lithic assemblages from the Zagros Mountains, presented and discussed in chapters 5, 6, and 7, and in this chapter, is sufficient to invalidate the longstanding assumption that the Zagros Mousterian is a coherent and well-defined techno-complex, and that this techno-complex can be explained through the "Summer Adaptation Hypothesis".

Evaluating the work of Lindly (1997), from his otherwise excellent and extensive lithic analyses and synthesis of his sample sites, through his knowledgeable and exhaustive discussion of, and concatenation with, ethnographic land-use and animal ecology, it is my contention that an insurmountable discrepancy between the Zagros lithic assemblages, as a homogenous Zagros Mousterian techno-complex, and the evidence of inter-site techno-typological variability, conveyed in this thesis, exists. This contention is irrespective of whether or not the Pleistocene climate would have permitted multi-seasonal land-use.

To put this another way, even if the techno-behavioural system Lindly (1997) identifies had been fully corroborated by the data in my study (which it has not), it still could *not* be said to be unique to the Zagros Mountains, as on the one hand, similar techno-typological signatures are found within assemblages in the Levant, and, on the other hand, the gross inter-site variability extant among the Zagros sites themselves (i.e. Shanidar and Warwasi compared to Houmian), would seem to contradict such assertion of techno-behavioural consistency needed to convincingly argue the case for a techno-complex.

I have compared the Zagros assemblages presented with that of a Levantine Mousterian, with the purpose of testing Lindly's (1997) "Summer Adaptation Hypothesis". As the main hypothesis, set out in the introduction, as to whether the Zagros Mousterian techno-complex truly can be said to be the expression of highland summer adaptation, it was also of interest to explore if these assemblages could shed light on the issue of the recent questioning of the continued use of Bordes (1961) typology (Bisson 2000; Shea 2014). For example, to what extent the Zagros Mousterian techno-complex is a product of the Levantine Mousterian techno-complex, i.e. to what degree – since the former was coined later in a research-historical context than the latter – the Zagros Mousterian techno-complex is defined on *what it is not* (i.e. in relation to the Levantine Mousterian). It is certainly true that epistemologically, all the right scientific factors were present for the Zagros Mousterian to be created when it was: the culture-historical narrative of the mid-20th Century, driven as it were by a typological descriptive framework of lithic artefacts for explaining culture change (e.g. Bordes 1951, 1961). In conjunction with this, the diversity of regions (e.g. Zagros vs. Levant, highlands vs. lowlands), set the stage for the reasoning of the assumption that behavioural variability was inevitable between the two: the obvious environmental contrasts entailing variety in game animals, which in turn presupposes the assumption of discernible variability in stone tool production and discard. Archaeologically, this was primarily tied up on the proposed importance of differences in extent in retouch intensity. I will argue that too much emphasis (and thereby behavioural interpretation) has been put on the significance of retouch intensity within highly (post-excavationally-) curated assemblages. I will argue that while an increase in retouch intensity can be claimed to be prevalent within Zagros- as opposed to Levantine assemblages, it should not necessarily justify the creation of a separate techno-complex. In fact, the *a priori* separation of Middle Palaeolithic assemblages into complexes, based on physical proximity to the Zagros or the Levant, seems to be based rather on geographical and environmental attributes than strictly lithic variability. As such, the Zagros Mousterian could be argued to be the product of ontological uber-zeal rather than techno-behavioural realities. In these situations, Alison Wylie reminds us:

"[w]*hat you find, archaeologically, has everything to do with what you look for, with the questions you ask and the conceptual resources you bring to bear in attempting to answer them*." (Wylie 2002:xiv)

As such, it is my conclusion that while Skinner's (1965) typological definition of the Zagros Mousterian had value then as a heuristic contrivance, Lindly's (1997) techno-behavioural framework, although presented as both the key to understanding the inner workings of Skinner's techno-complex and to explain the material-culture patterning of sites in the Zagros, ended up being a justification for the Zagros Mousterian techno-complex's continued relevance. Accordingly, this dichotomy of 'typologically-grounded techno-complex' and 'techno-behavioural explanatory framework' ends up as circular argumentation: 'the Zagros Mousterian is a techno-complex because it represents distinct typological variability', and 'the typological variability can be explained behaviourally as a distinct techno-complex'.

Consequently, it might be time to retire the notion of the Zagros Mousterian altogether, as its *raison d'être*, as mentioned above, as a culture-historical heuristic framework can be argued to have outlived its usefulness for providing answers to the questions of behavioural change in material culture, we are preoccupied with today.

Its continued usage, through Lindly's model – complete with its assumption of single-season-land-use exclusivity – amounts to a disservice to both the hominins who produced the material record in the Zagros, and the ones who now are trying to reconstruct it.

Chapter 10 - Conclusion

10.1 Concluding remarks

Lindly (1997, 2005), supporting Skinner (1965), has claimed that the Zagros Mousterian is a distinct techno-complex, and that Middle Palaeolithic lithic assemblages within the Zagros Mountains can be studied and explained as a homogenous entity. Lindly postulates the Zagros Mousterian is a techno-behavioural expression of hominin summer adaptation, specifically designed to manage lithic raw material scarcity, alleged to have been a factor, within lowland to highland mobility strategies of high altitude land-use, and claimed to be evident in techno-typological observations made within various Zagros Middle Palaeolithic assemblages (Lindly 1997, 2005).

In this thesis, I have called this argument by Lindly the "Summer Adaptation Hypothesis". I wanted to test this hypothesis, as its refutation would open up for the possibility of more behaviourally diverse interpretive schemes for late Middle and Late Pleistocene hominin adaptation in the Zagros Mountains, and implicitly extend more behaviourally complex agency to those hominins, specifically Neanderthals.

In Chapter 2, I summarised the contextual conditions of the Middle Palaeolithic in southwest Asia, by presenting a history of research, before outlining various theories and heuristic tools with which to engage in interpretive models for explaining hominin behaviour as expressed in material culture. It was a premise of the thesis that it is necessary to understand the Mousterian Zagros assemblages within a context of not just montane southwest Asia, but southwest Asia as a whole. For that reason, I chose to incorporate a comparative analysis with assemblages from a completely different context, from a site situated at a much lower altitude, in a dissimilar macrozone of the coastal Levant: Ksar Akil. It was my assumption that in order for the Zagros Mousterian to be considered a homogenous techno-complex – and functionally fit for purpose as an explanatory framework – the material culture found in the Zagros, when compared to assemblages from the Levantine Mousterian, would have to corroborate Lindly's (1997) model.

Of special notice in Chapter 2 was a discussion of the three spheres of behavioural complexity: symbolism, fauna, and technology. While the sites studied in this thesis have not been systematically discussed from a perspective of the symbolic- or faunal sphere, the author acknowledges that examining the study sites, especially with regards to fauna, would have been beneficial for the interpretation of site use, inter-site variability, as well as possibly on the period of occupation highlighted by the lithic study. However, as mentioned previously, due to the contextual issues and preservational conditions of the published faunal material from the three Zagros sites, which makes direct correlation to the lithic assemblages challenging, if not impossible, inclusion of material from the faunal sphere was rejected. Inclusion of material from the symbolic sphere was regarded beyond the scope of this present thesis. Future fieldwork and publications are likely to develop the potential of direct linkage between material from all three spheres from the sites presented here, which would permit such future studies to offer more inclusive and holistic analyses.

The issue of chronology, in particular the question of chronological contemporaneity, both inter- and intra-site, between Zagros sites and site assemblages were presented and discussed. It was found that the range of radiometric dates available, combined with the existing environmental proxies, as well as techno-typological affinities, situate the Zagros Mousterian, broadly, within the ranges of the Levantine Mousterian. The Zagros sites studied in this thesis, as well as the Levantine Mousterian site of Ksar Akil, could be said to be broadly chronologically contemporaneous, and therefore suitable for comparative studies. The assumption of broad chronological contemporaneity was compatible with the framework Lindly (1997) employed when defining the Zagros Mousterian as a techno-behavioural adaptational system, and therefore acceptable as a framework of comparison.

In Chapter 3, I presented a climatic, environmental, and physiographic background to the study areas in the Zagros Mountains, in order to achieve an understanding of the immense complexities inherent in the reconstruction of palaeoenvironments, and to demonstrate how both large- and small-scale factors can influence archaeological site variability. I also outlined a recent model of Palaeolithic landscape in the Zagros Mountains, in order to better situate my study sites.

In Chapter 4, I introduced an appropriate methodology with which to analyse selected lithic assemblages, in order to acquire an appreciation of the extant lithic variability. I wanted to test the extent of homogeneity or variability of lithic assemblages within the Zagros Mountains, and discuss my results in context with those of Lindly.

In chapters 5-7, I analysed sample assemblages from the sites of Houmian, Warwasi, and Shanidar located within the Zagros Mountains.

In Chapter 8, I analysed sample assemblages from the site of Ksar Akil in the Levant.

In Chapter 9, I compared and discussed the assemblages from the four sites.

Based on my analyses of three Zagros assemblages and one Levantine Mousterian assemblage, and through my discussion of the outcome of these analyses against the premise of Lindly (1997), I argue that it is premature to write off completely the possibility of the Zagros Mountains being occupied by hominins outside summer seasons during periods of the late Middle and Late Pleistocene. For this reason, the so-called Zagros Mousterian should not be viewed exclusively as a summer adaptation. Indeed, it should not be viewed as a coherent techno-complex at all. Rather, the Mousterian Zagros assemblages should be regarded as Middle Palaeolithic "Mousterian" adaptations endemic to their specifically individual – granted, high altitude – locales, and whatever climatic or environmental regime was governing that area at that particular time. It is clear from the analysis of the material from Houmian that this assemblage, while unquestionably a Middle Palaeolithic, "Mousterian" techno-typological entity, cannot be assigned to the so-called Zagros Mousterian. These local inter-montane lithic variabilities of Middle Palaeolithic techno-typology, combined with the results of the comparative analysis and discussion of the Ksar Akil assemblages reinforces this position.

In my thesis I have identified a research question, provided a critical assessment of literature relevant to the topic of my research question, described the methodology used to engage with the research question, and applied this methodology to various datasets relevant to the testing of the hypothesis generated by the research question. I have described the outcome of my data analyses and discussed its implications for the research question. The conclusion of my research, through testing and successfully falsifying the "Summer Adaptation Hypothesis", the answer to my research question identified in my introduction, is as follows: The understanding of the Zagros Mousterian as a summer-seasonal adaptation cannot be upheld based on the extant data. Moreover, since the understanding of the Zagros Mousterian as a techno-behavioural adaptation to summer-seasonal exploitation of highland environments, was based on the premise that the Zagros Mousterian was a techno-behavioural entity, the corollary is that the substantiation for the Zagros Mousterian as a distinct techno-complex dissipate. Without the former, the latter cannot exist.

10.2 Future directions

Going forward, and based on some of the issues explored in this thesis, three levels of future research is outlined below.

10.2.1 Environmental proxy data production

Palaeoenvironmental reconstruction based on core drillings in lakes and on land, the study of speleothems in caves, pollen samples from excavations, and more chronometric dates, etc. is needed across the entire region of southwest Asia, but in particular in the Zagros. This is one of the main reasons the Zagros has seen so relatively little Palaeolithic investigation compared to other regions, and the main reason its old lithic collections have largely been ignored in the grand narrative of hominin behavioural and technological evolution. It is a vicious circle: old collections with poor contextual data does not cause for much excitement or interest. Lack of interest curtail the production of fresh datasets. By producing new, firm geochronological frameworks for the Zagros, renewed possibilities will be created for which to anchor archaeological assemblages, accelerating interest in producing these assemblages, increasing knowledge production and thereby integrating assemblages into a site-, local-, and regional narrative.

10.2.2 Re-excavation of Zagros sites

Excavation of new sites and re-excavation of "old" sites are under way in the Zagros. The renewed excavation at Shanidar Cave is one such example of modern research enabling much needed contextualisation of material culture through advances in the natural sciences. This is very positive for our knowledge production. It would be the recommendation of this thesis that "old" sites like Houmian and Warwasi be re-excavated, in order to obtain a sound chronometric dating scheme, as well as proxies for palaeoenvironmental reconstruction. This could significantly contribute to a better scientific utilisation of their "old" lithic collections. Until better proxies are available, it is difficult to extend our interpretive schemes of "old" lithic collections much further. The lack of dates and environmental contexts makes gaining any significantly profound ground very difficult compared to what can be expected from assemblages obtained from modern excavations.

10.2.3 Lithic use-wear analysis

It would potentially be rewarding to explore the possibilities of lithic use-wear analysis of scrapers or points. Looking into possible function and intra-site use of a tool-type such as scrapers, by far the largest tool category at Bisitun (Dibble 1984a: 26), and Warwasi (Dibble and Holdaway 1993), but also prevalent at other sites like Shanidar (Solecki and Solecki

1993) and Kunji Cave (Baumler & Speth 1993), in order to broaden the interdisciplinary range of the analysis (Claud et al. 2012; Dockall 2015; Bewley 1984: 23; see also Bye-Jensen 2018; La Porta 2019). Such study could potentially supply novel insights into the functionality of this tool group, providing clues into what materials were being targeted for exploitation. This might offer information about seasonality, if seasonally sensitive material could be proven to have been manipulated.

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Appendix

This appendix provides an overview of a selection of the lithics analysed in the thesis. This is for reference only, and is not intended to provide an exhaustive account. No photos were taken of the relevant Ksar Akil layers analysed (i.e. Square E5, layers 28A, 27A, and 26A). Material from Ksar Akil layers 28 and 32 (Square F4) will be used to illustrate the material analysed from Ksar Akil.

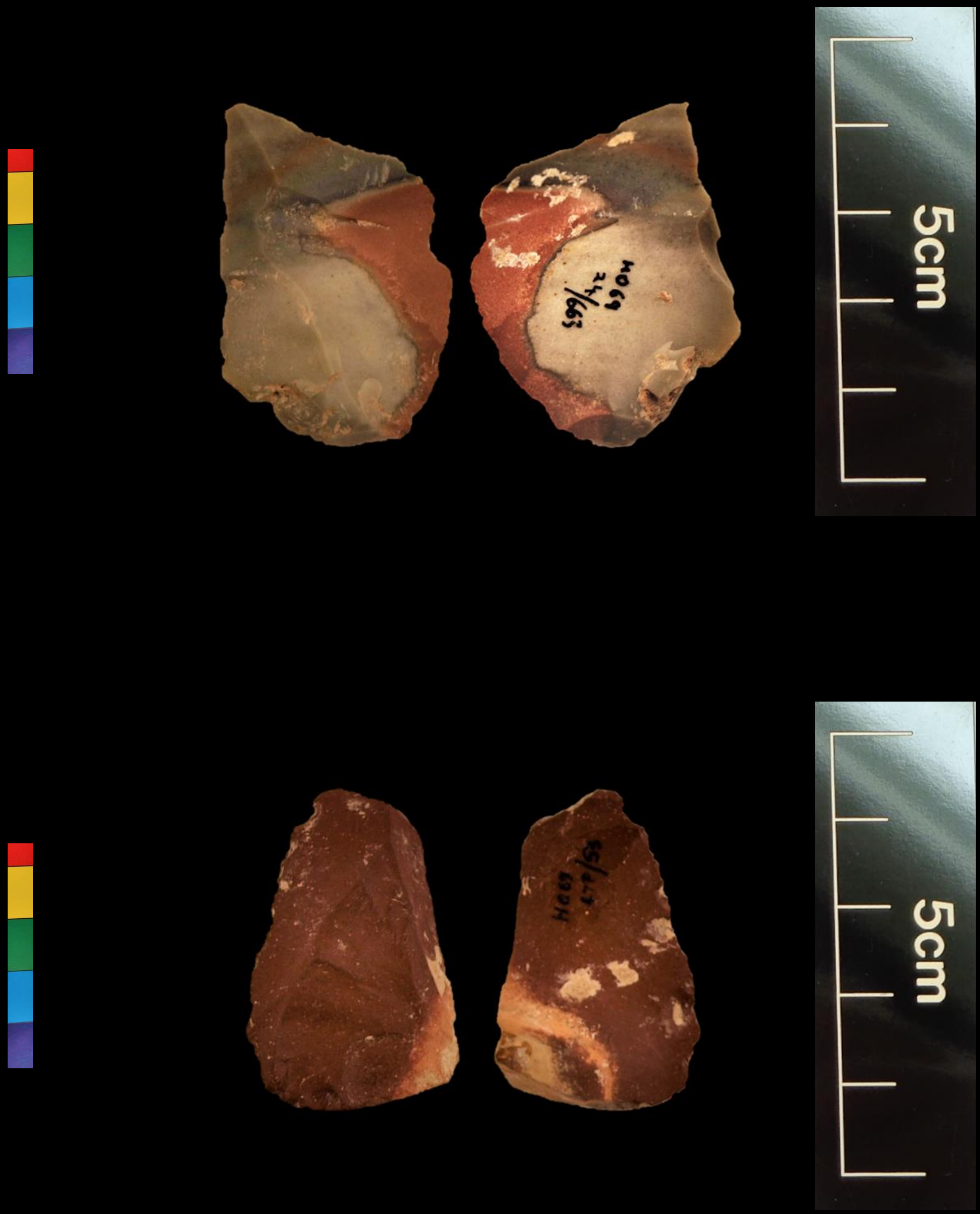

Plate 1: Houmian selection of lithics – Top and bottom: Levallois flake

Plate 2: Houmian selection of lithics – Top and bottom: Levallois flake

Plate 3: Houmian selection of lithics – Top and bottom: Levallois flake

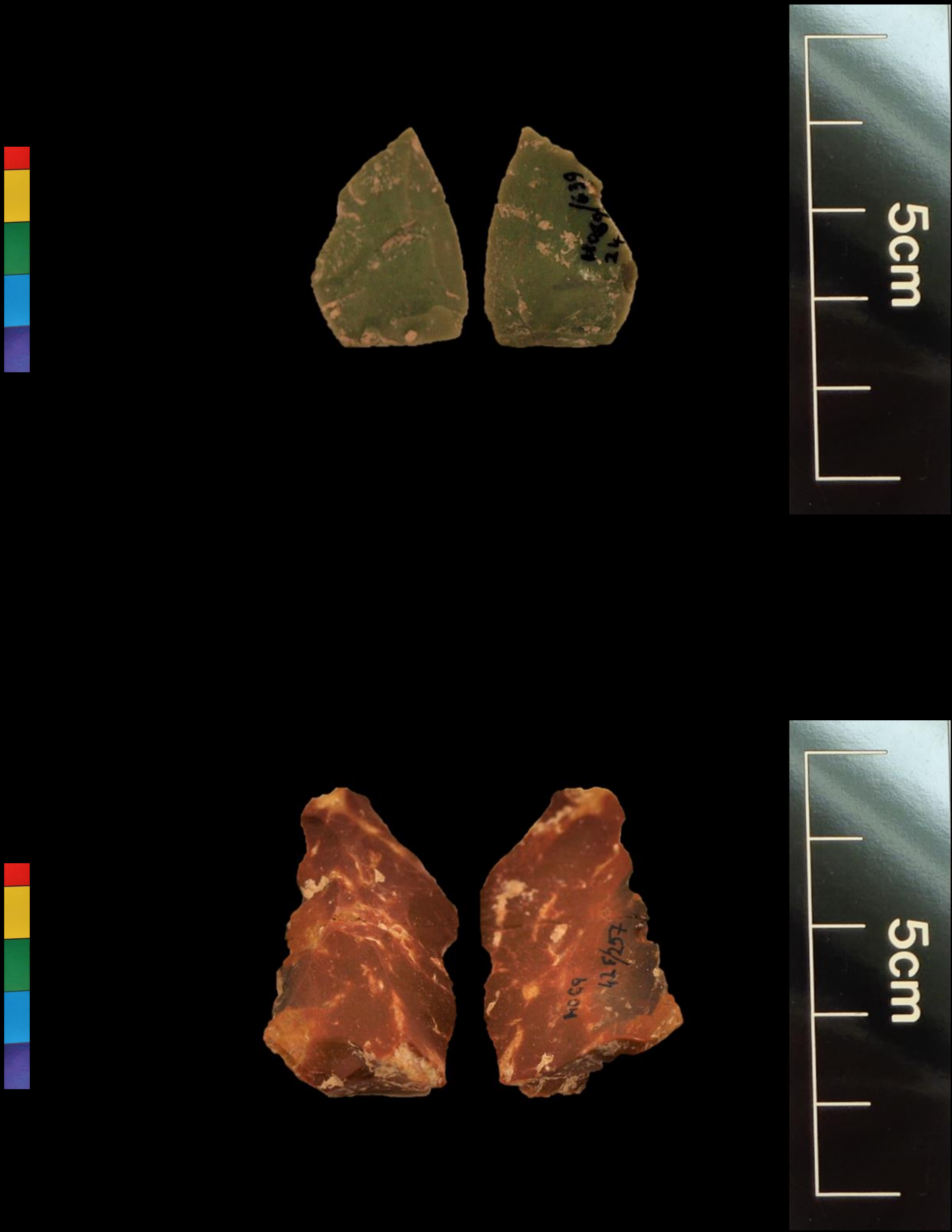

Plate 4: Houmian selection of lithics – Top and bottom: Levallois flake

Plate 5: Houmian selection of lithics – Top and bottom: Levallois flake

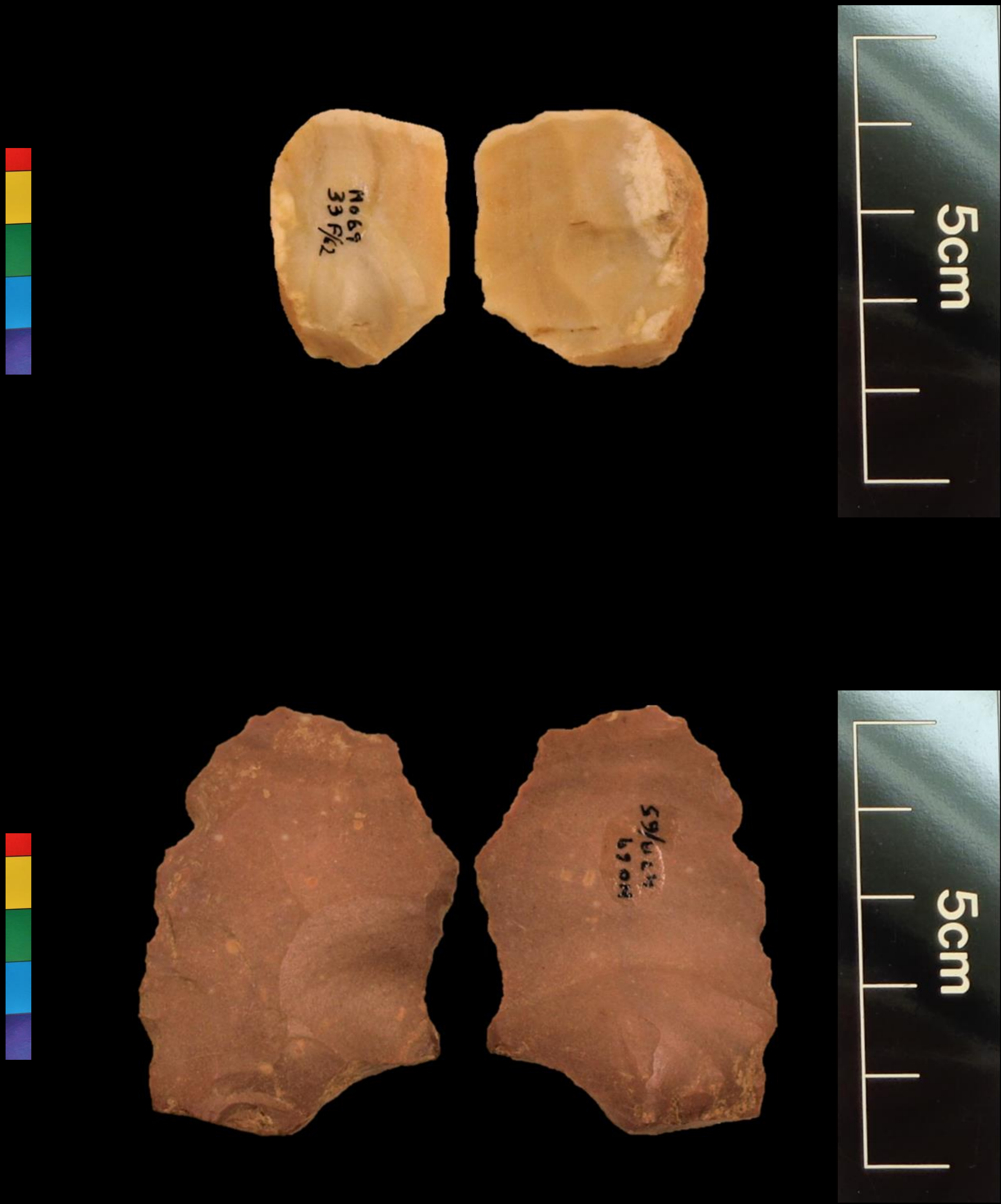

Plate 6: Houmian selection of lithics – Top: Levallois flake; Bottom: Retouched Levallois flake

Plate 7: Houmian selection of lithics – Top and bottom: Retouched Levallois flake

Plate 8: Houmian selection of lithics – Top and bottom: Retouched Levallois flake

Plate 9: Houmian selection of lithics – Top and bottom: Retouched Levallois flake (top: composite photo)

Plate 10: Houmian selection of lithics – Top: Retouched Levallois blade; Bottom: Mousterian point (Bottom: composite photo)

Plate 11: Shanidar selection of lithics – Top: side-scraper; Bottom: Double scraper

Plate 12: Shanidar selection of lithics – Top and bottom: convergent scraper

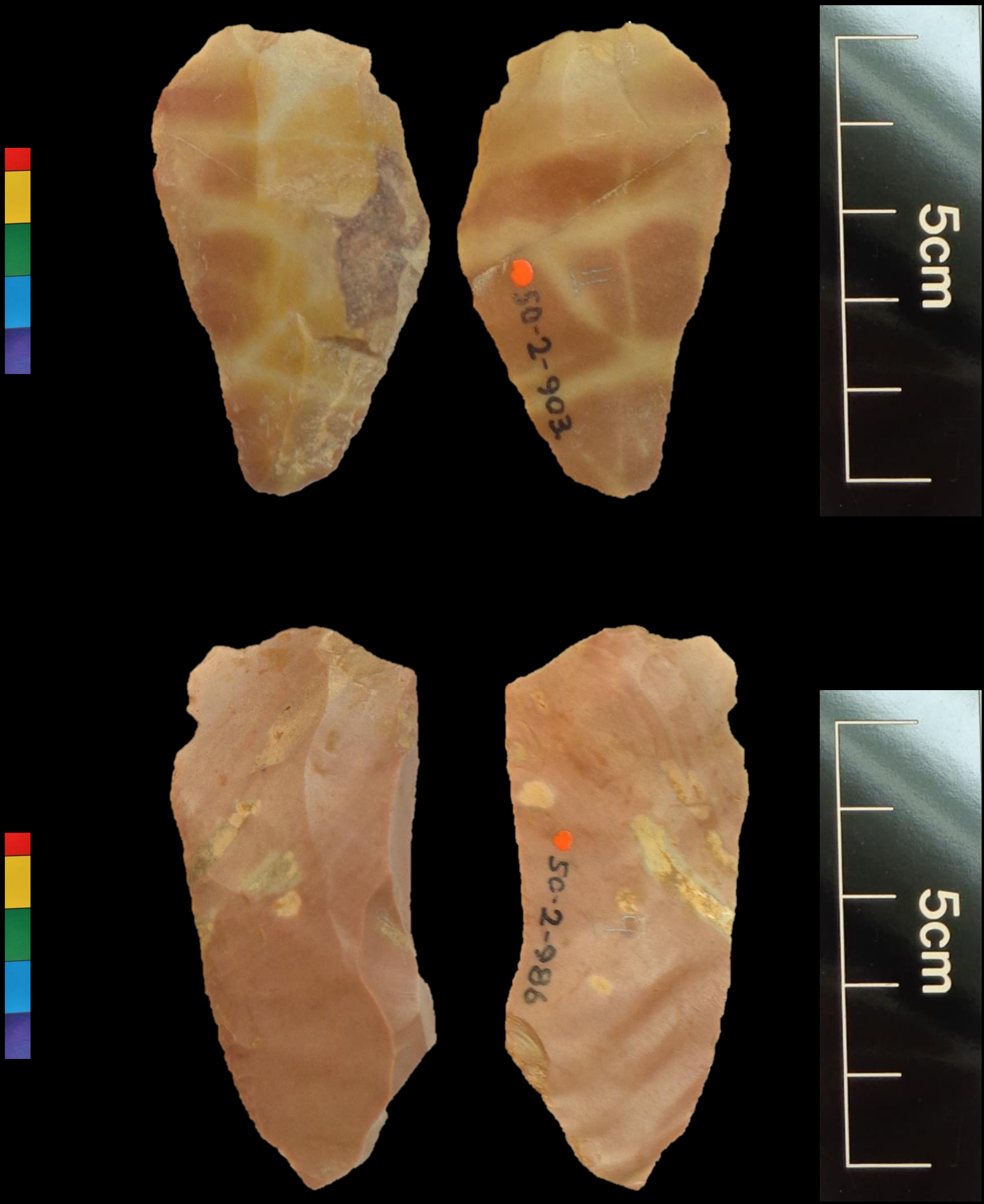

Plate 13: Shanidar selection of lithics – Top: convergent scraper; Bottom: retouched Levallois blade

Plate 14: Shanidar selection of lithics – Top: Retouched Levallois blade; Bottom: retouched Levallois Flake

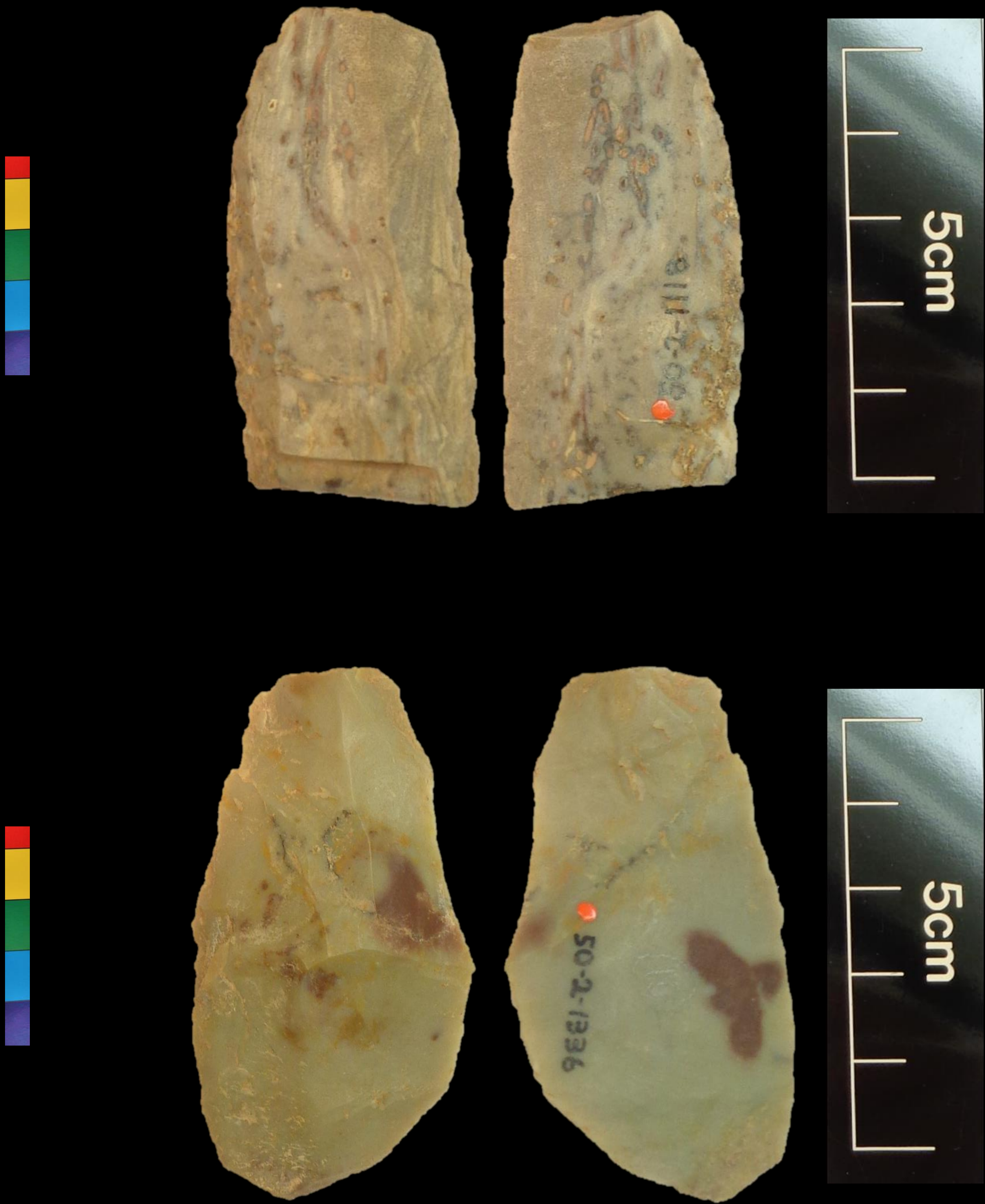

Plate 15: Shanidar selection of lithics – Top: retouched Levallois blade; Bottom: retouched Levallois Flake

Plate 16: Shanidar selection of lithics – Top and bottom: side-scraper on Levallois flake

Plate 17: Shanidar selection of lithics – Top: side-scraper on Levallois flake; Bottom: burin on Levallois flake

Plate 18: Shanidar selection of lithics – Top: core-on-flake; Bottom: retouched point on Levallois blade

Plate 19: Shanidar selection of lithics – Top: Mousterian point; Bottom: retouched Levallois point

Plate 20: Shanidar selection of lithics – Top and bottom: retouched Levallois point

Plate 21: Warwasi selection of lithics – Top and bottom: retouched Levallois points

Plate 22: Warwasi selection of lithics – Top and bottom: Levallois flakes

Plate 23: Warwasi selection of lithics – Top: Mousterian point; Bottom: side-scraper on Levallois flake

Plate 24: Warwasi selection of lithics – Top and bottom: Levallois flake

Plate 25: Warwasi selection of lithics – Top and bottom: Levallois flake

Plate 26: Warwasi selection of lithics – Top and bottom: Levallois flake

Plate 27: Warwasi selection of lithics – Top and bottom: retouched Levallois blade

Plate 28: Warwasi selection of lithics – Top: retouched Levallois blade; Bottom: Levallois blade

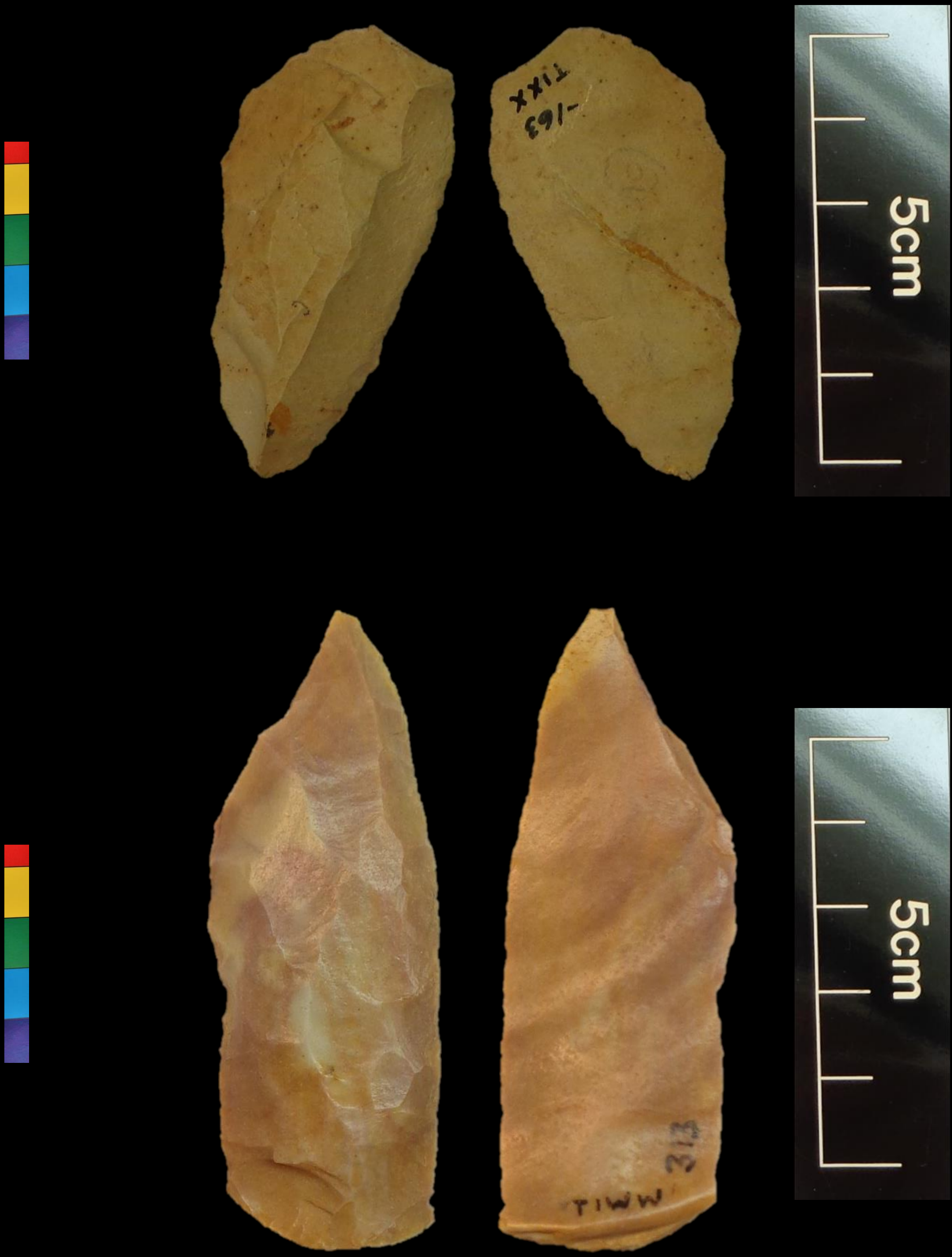

Plate 29: Warwasi selection of lithics – Top: retouched Levallois flake; Bottom: burin and side-scraper on Levallois flake

Plate 30: Warwasi selection of lithics – Top: convergent scraper; Bottom: retouched flake

Plate 31: Ksar Akil selection of lithics – Levallois flake

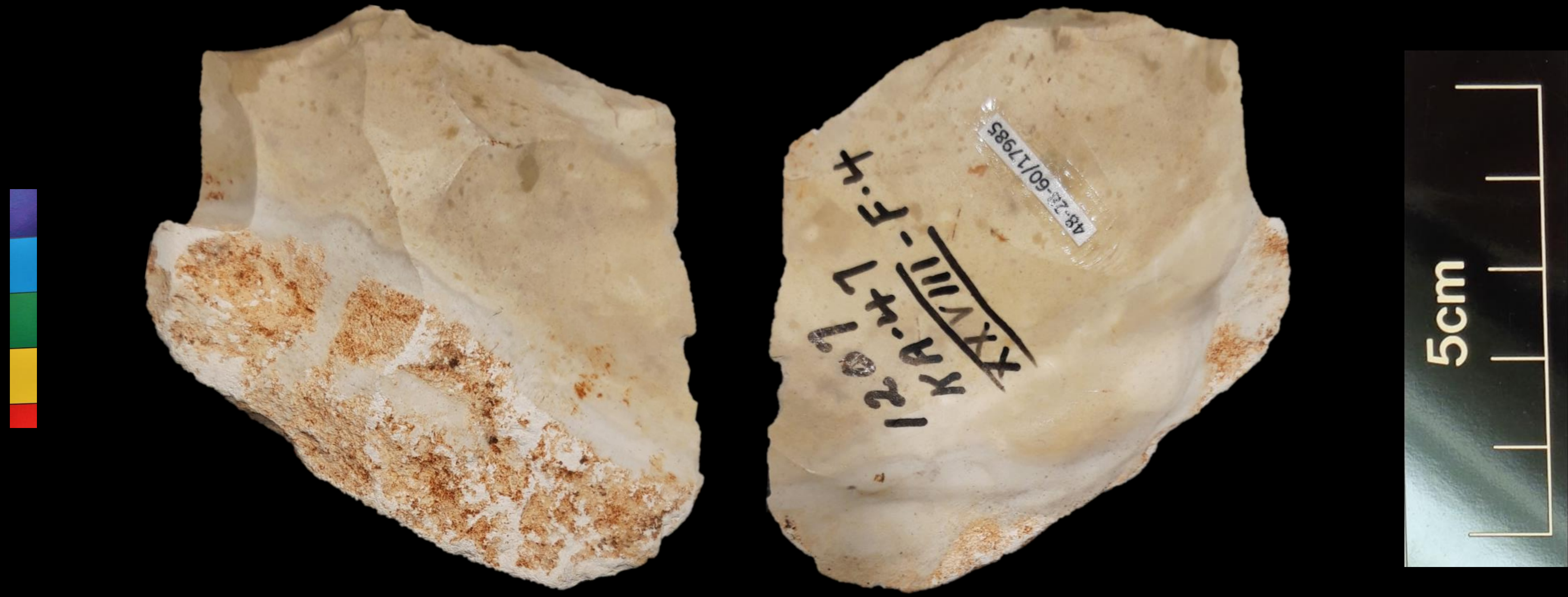

Plate 32: Ksar Akil selection of lithics – Levallois flake

Plate 33: Ksar Akil selection of lithics – Top and bottom: Levallois flake

Plate 34: Ksar Akil selection of lithics – Top and bottom: Levallois flake

Plate 35: Ksar Akil selection of lithics – Top and bottom: Levallois flake

Plate 36: Ksar Akil selection of lithics – Top: Levallois flake; Bottom: Retouched Levallois flake

Plate 37: Ksar Akil selection of lithics – Top and bottom: Retouched Levallois flake

Plate 38: Ksar Akil selection of lithics – Top and bottom: Levallois blade

Plate 39: Ksar Akil selection of lithics – Top and bottom: retouched Levallois blade

Plate 40: Ksar Akil selection of lithics – Top: Levallois blade; Bottom: Levallois point

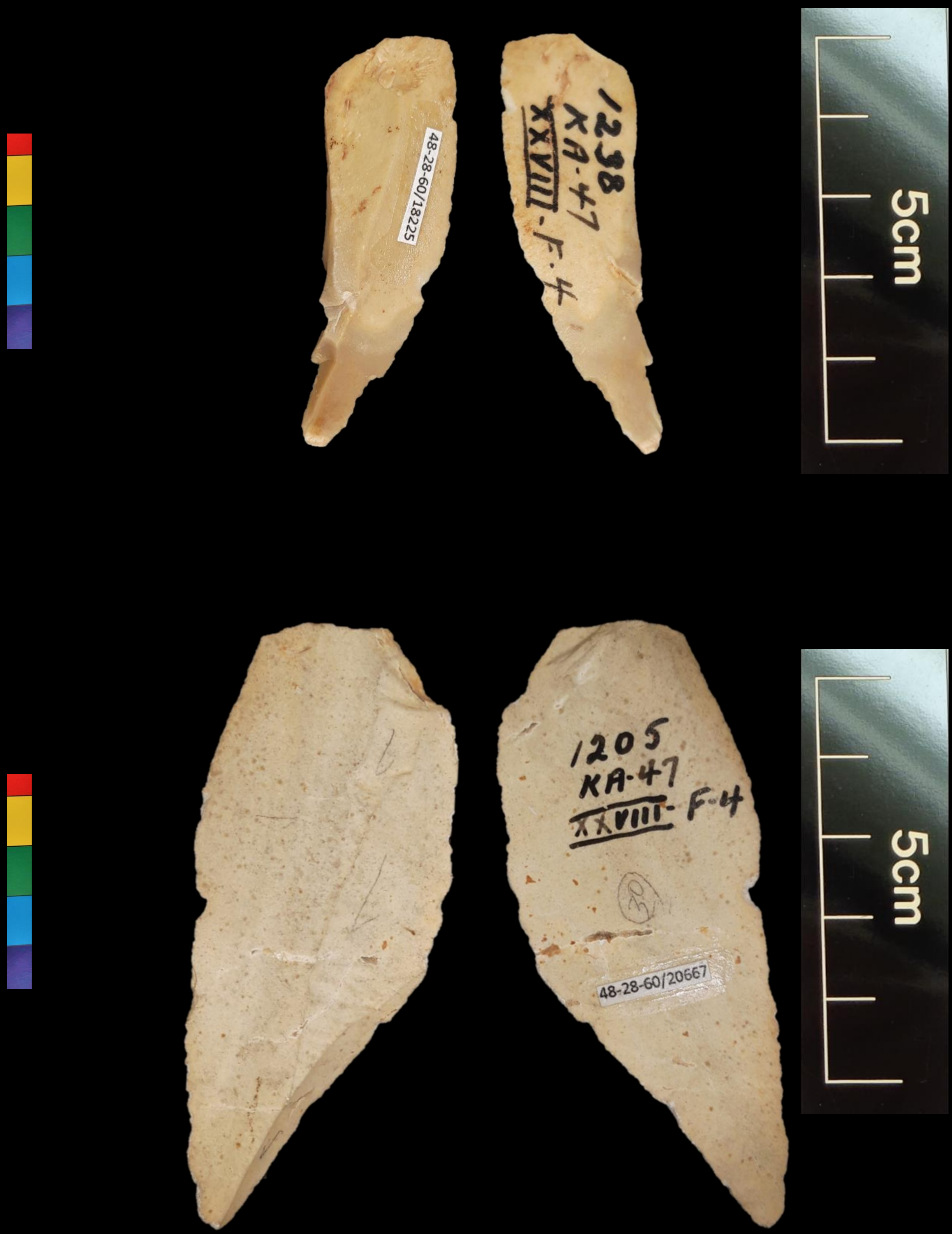

Plate 41: Ksar Akil selection of lithics – Top and bottom: burin